

1/50

FIG. 1
PRIOR ART

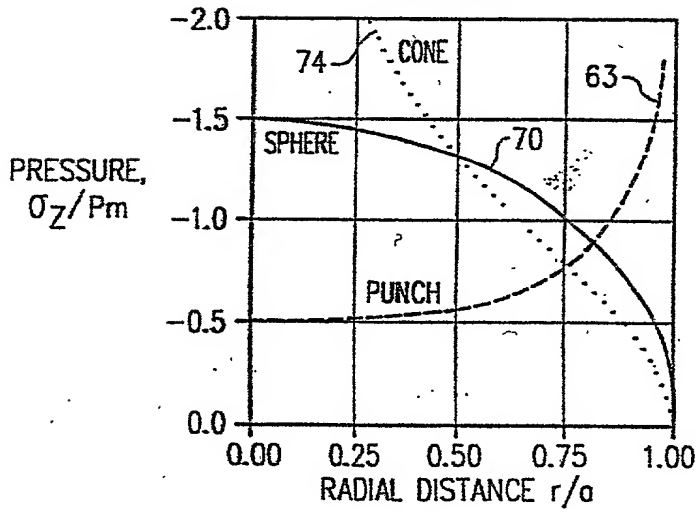


FIG. 2
PRIOR ART



FIG. 3
PRIOR ART

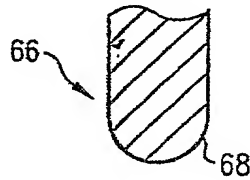


FIG. 4
PRIOR ART

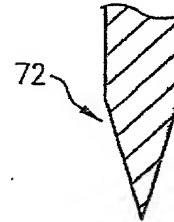
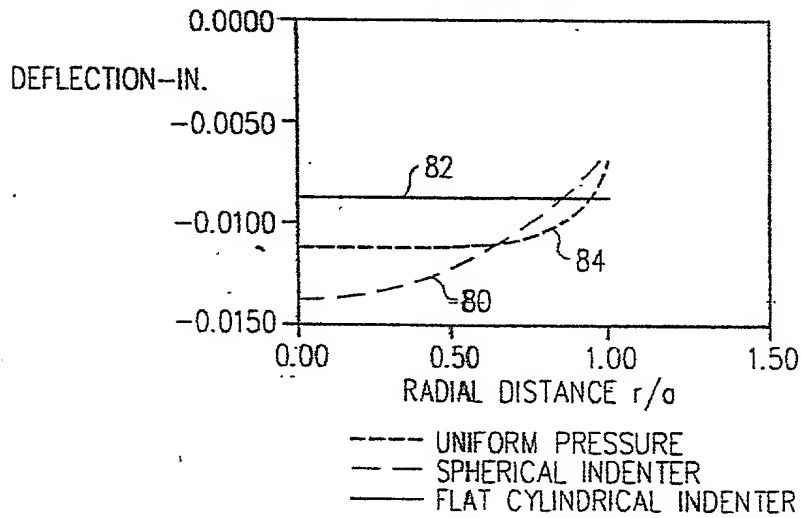


FIG. 5



2/50

FIG. 6

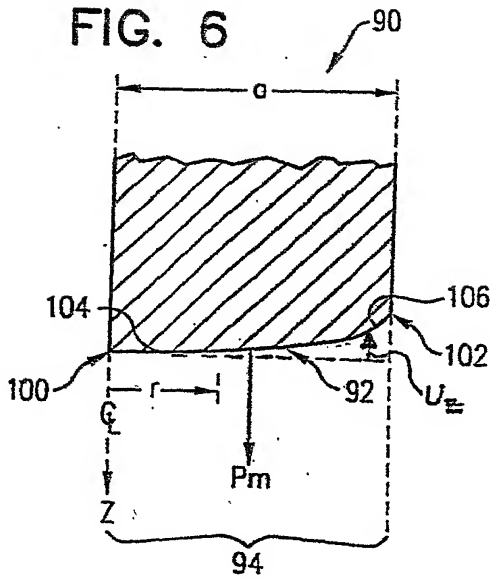


FIG. 7

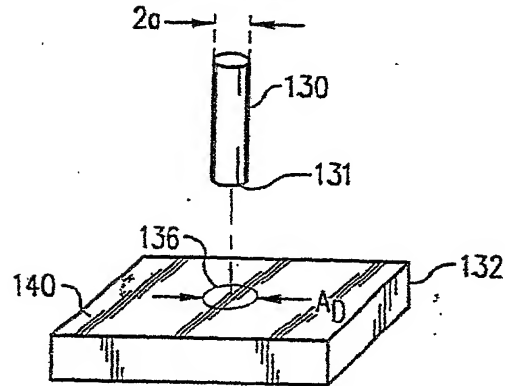


FIG. 8

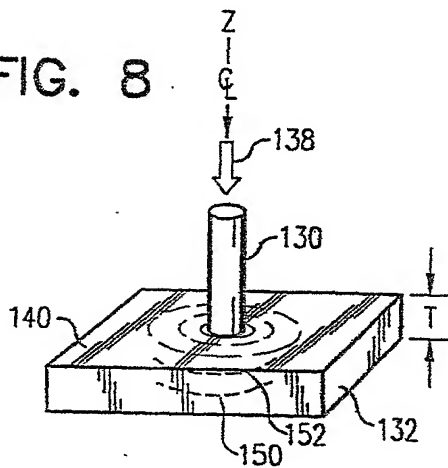


FIG. 9

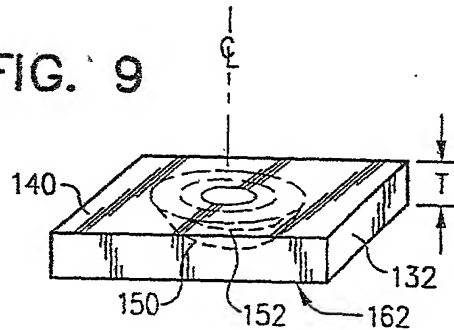
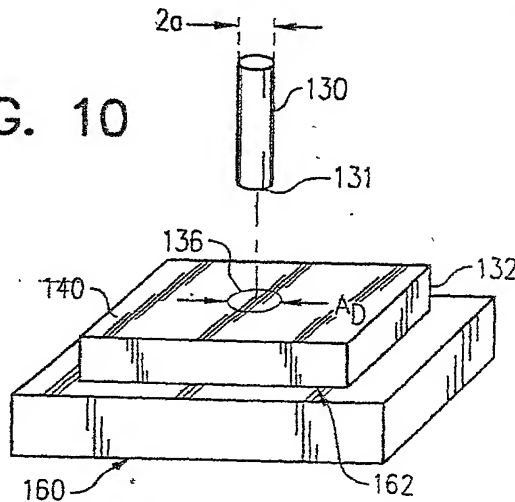


FIG. 10



3/50

FIG. 11

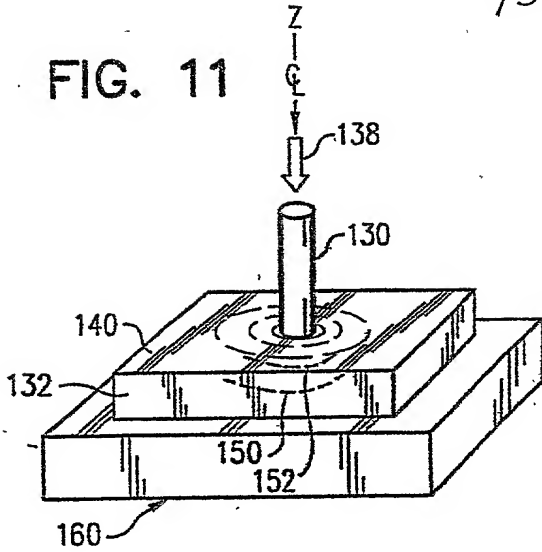


FIG. 12

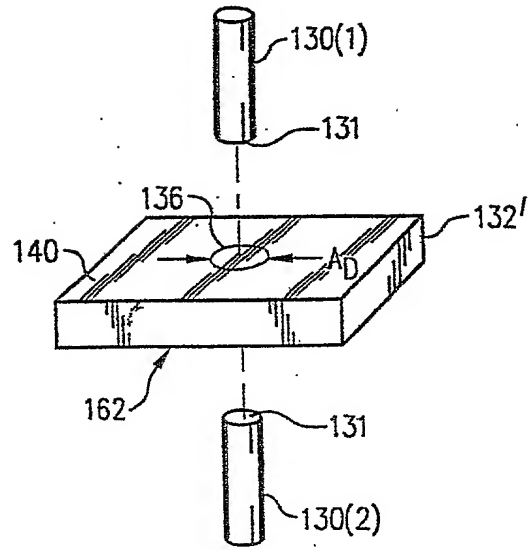


FIG. 13

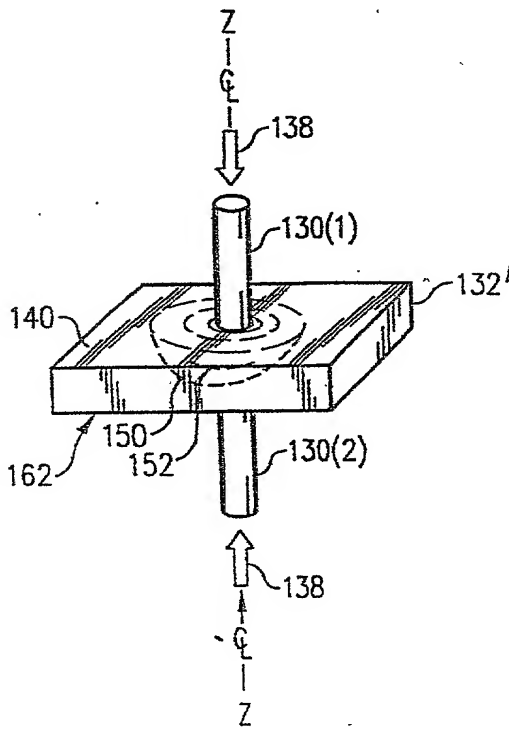
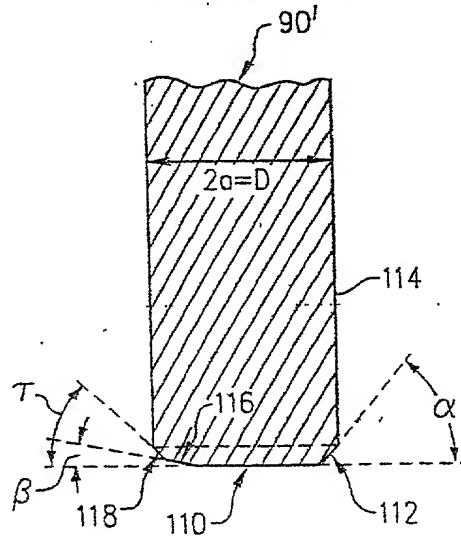


FIG. 14



200601080499001

4/50

FIG. 15

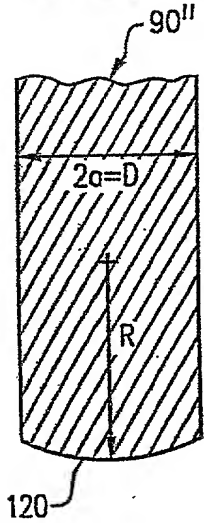


FIG. 16

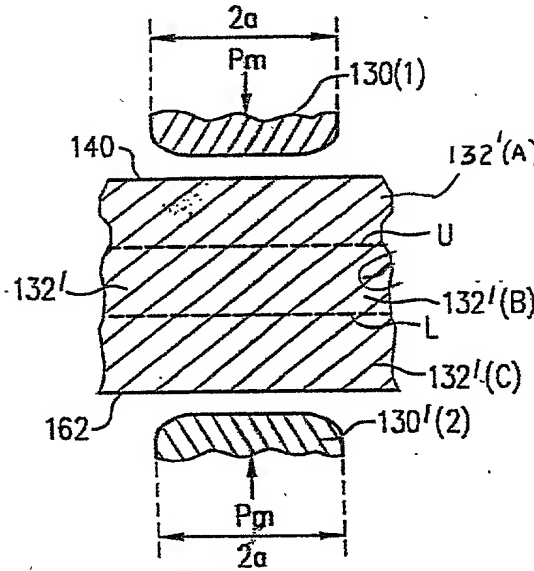


FIG. 17

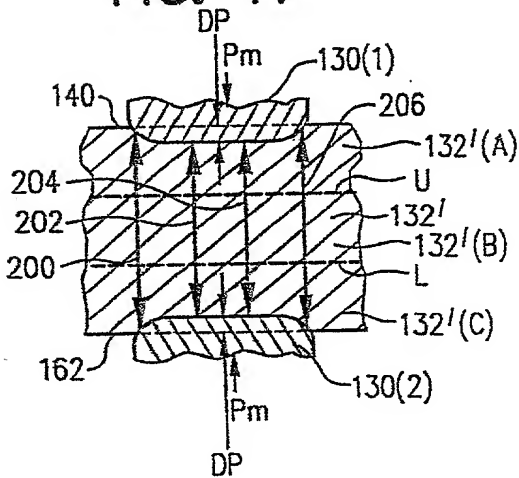


FIG. 18

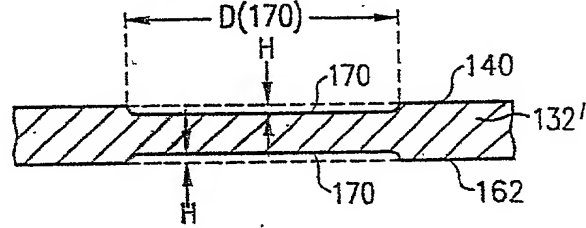


FIG. 19

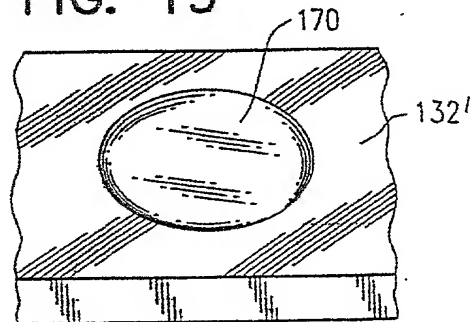
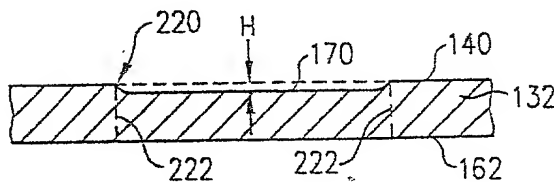


FIG. 20



2006408.01001

5/50

FIG. 21

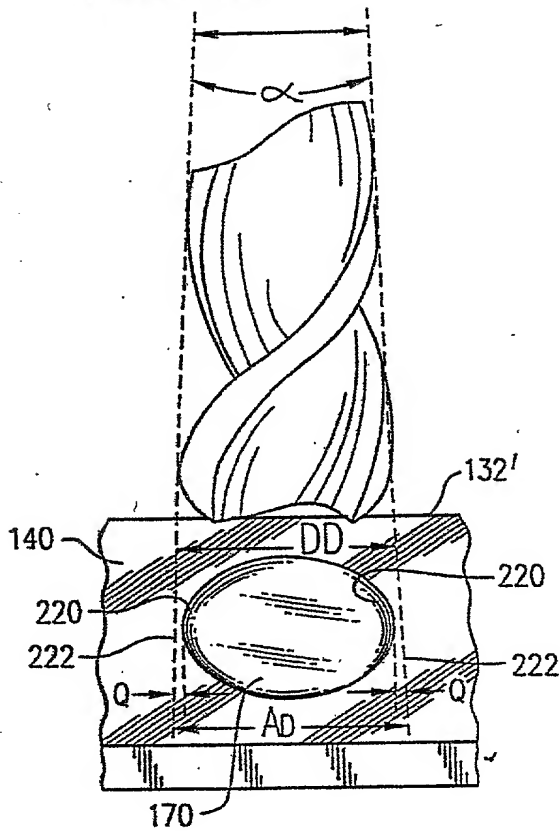


FIG. 22

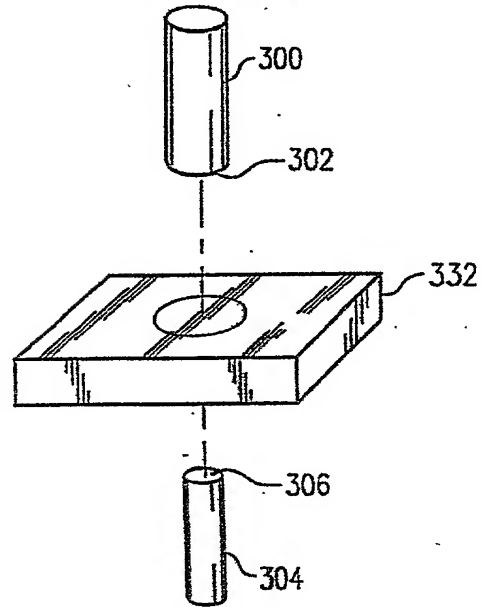


FIG. 24

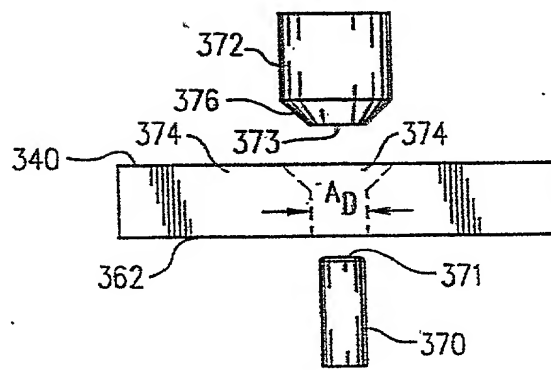


FIG. 23

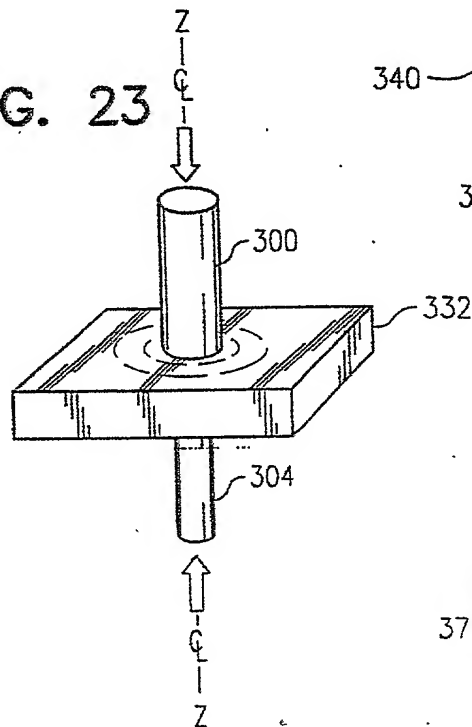
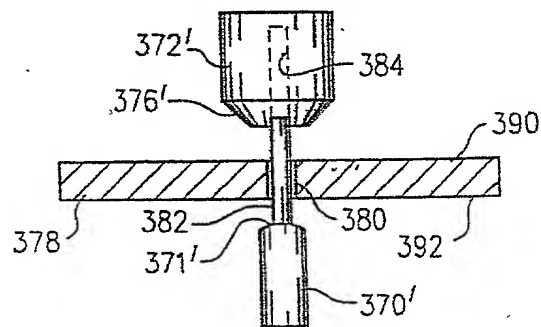


FIG. 25



2002-01-30-01

8/50

FIG. 35

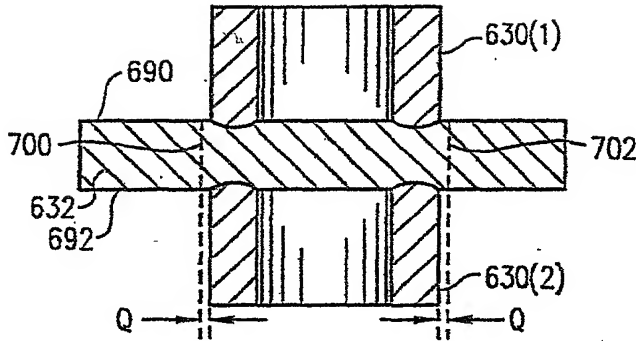


FIG. 36

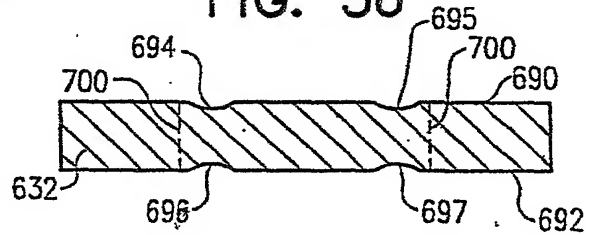


FIG. 37

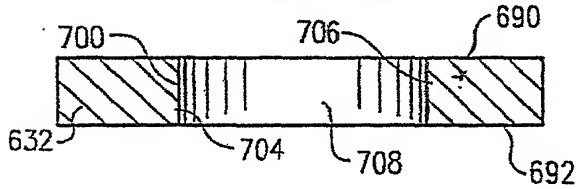


FIG. 48

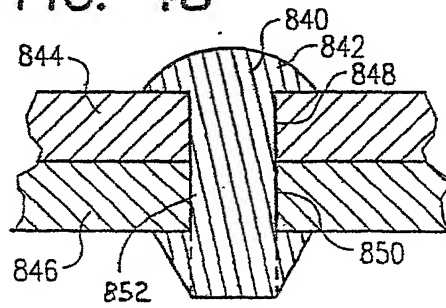
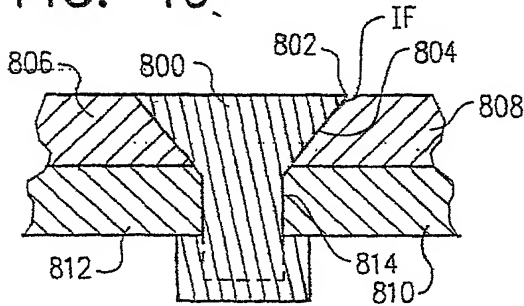


FIG. 49



200608010001

20020701 20499007

9/50

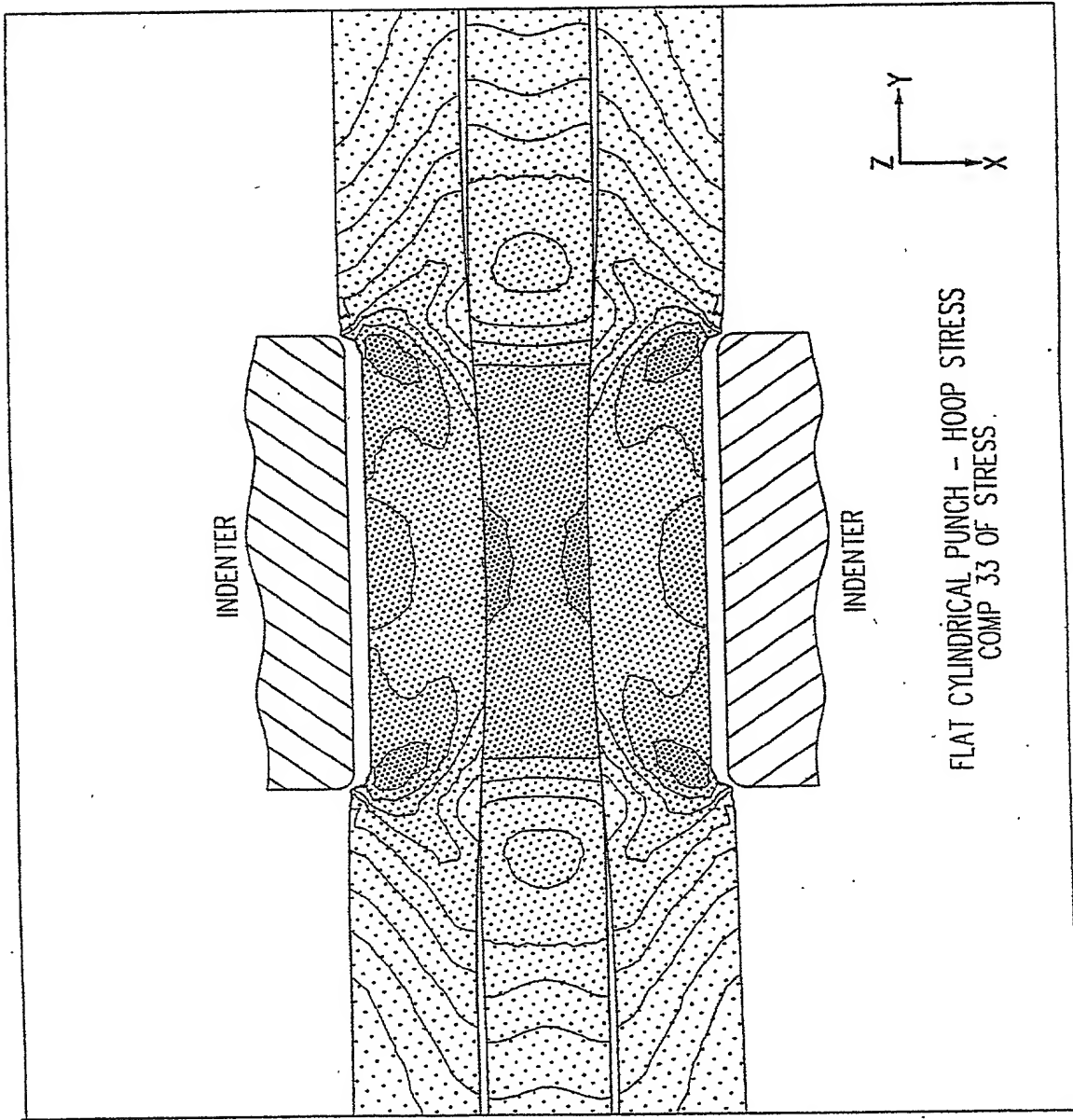
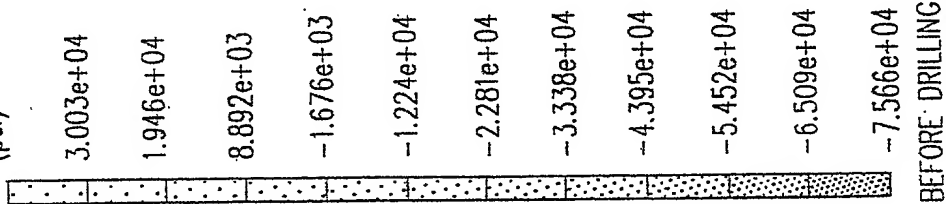


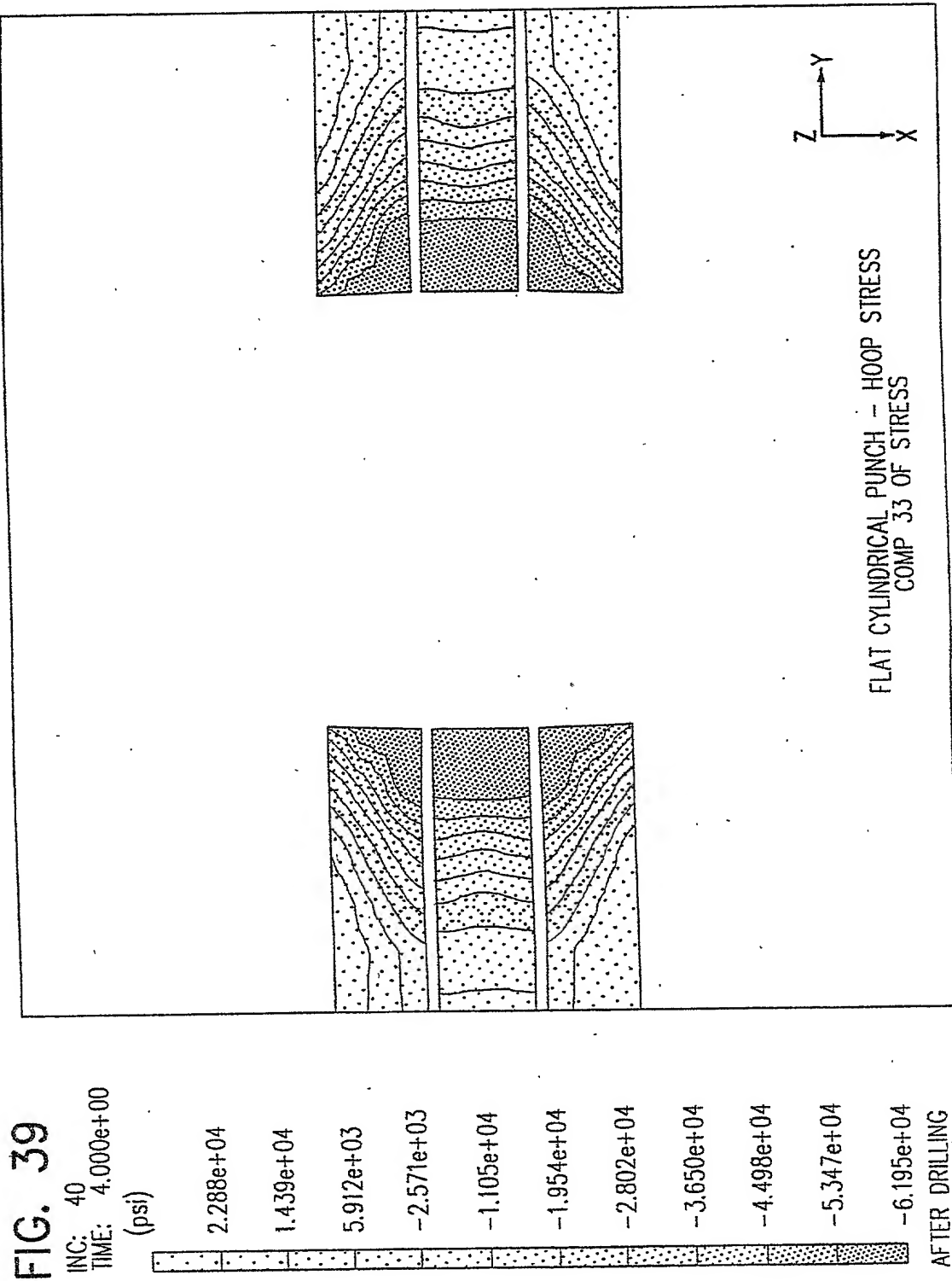
FIG. 38

INC: 30
TIME: 2.000e+00

(psi)

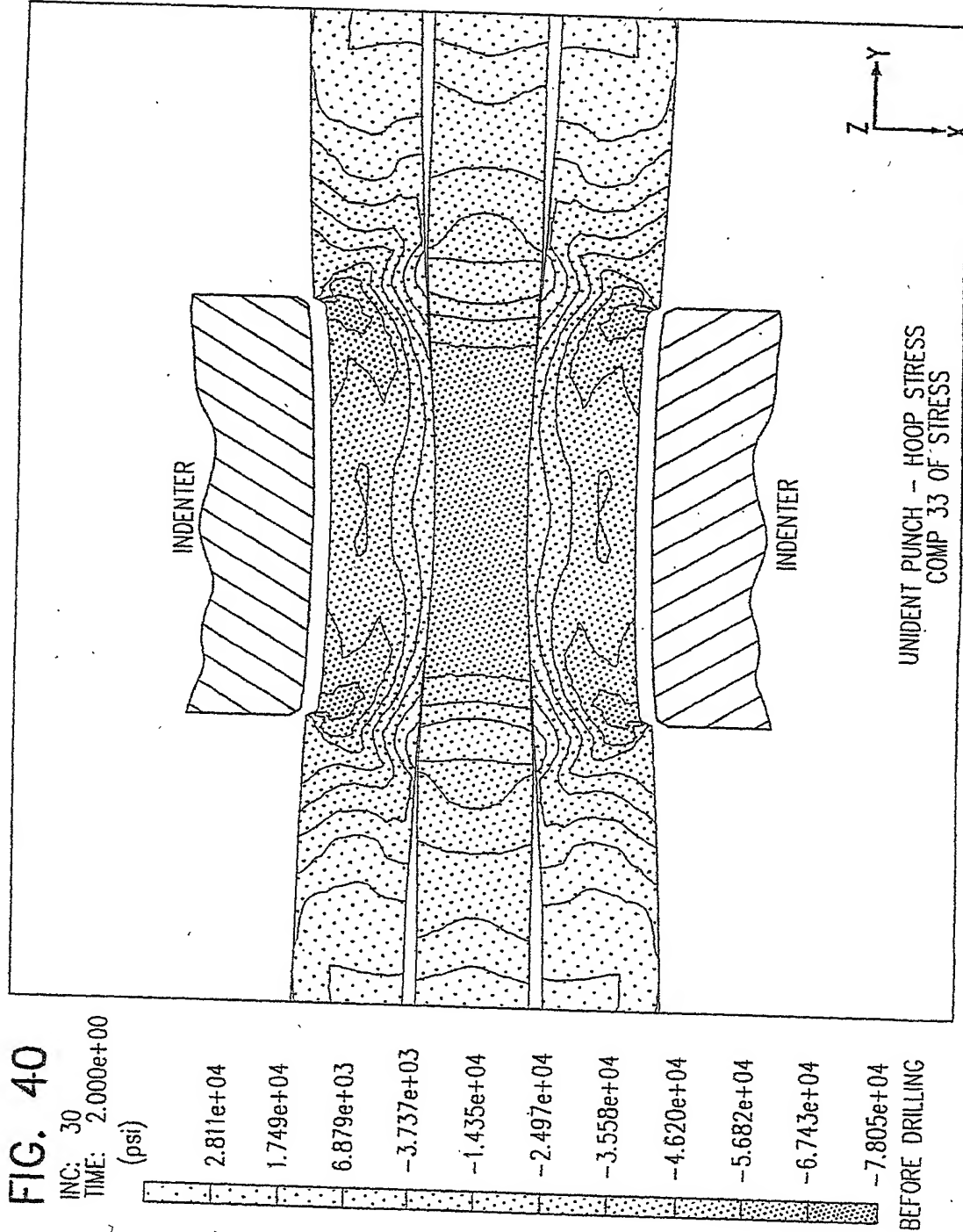


10/50



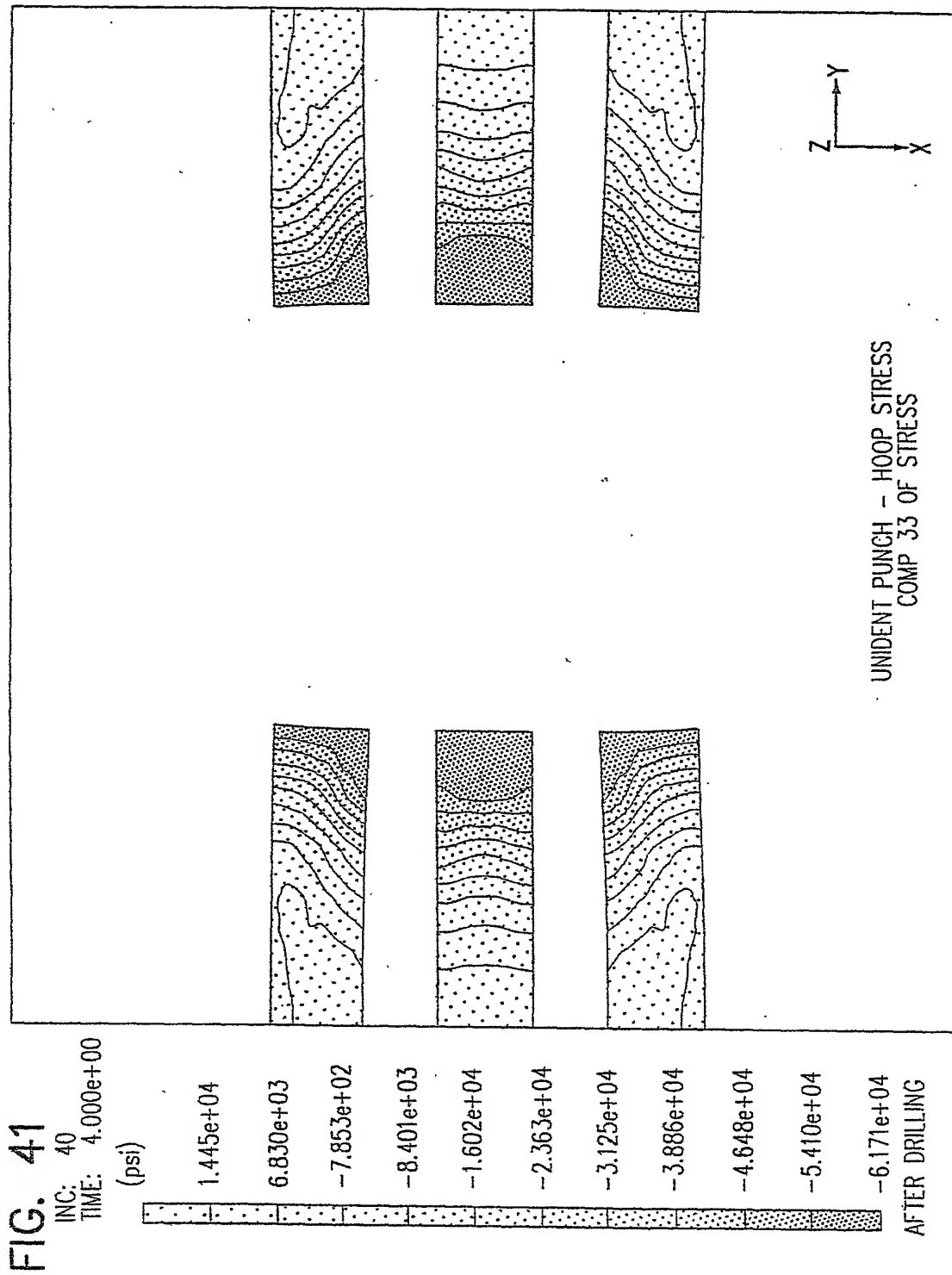
11/50

200610-8049900T

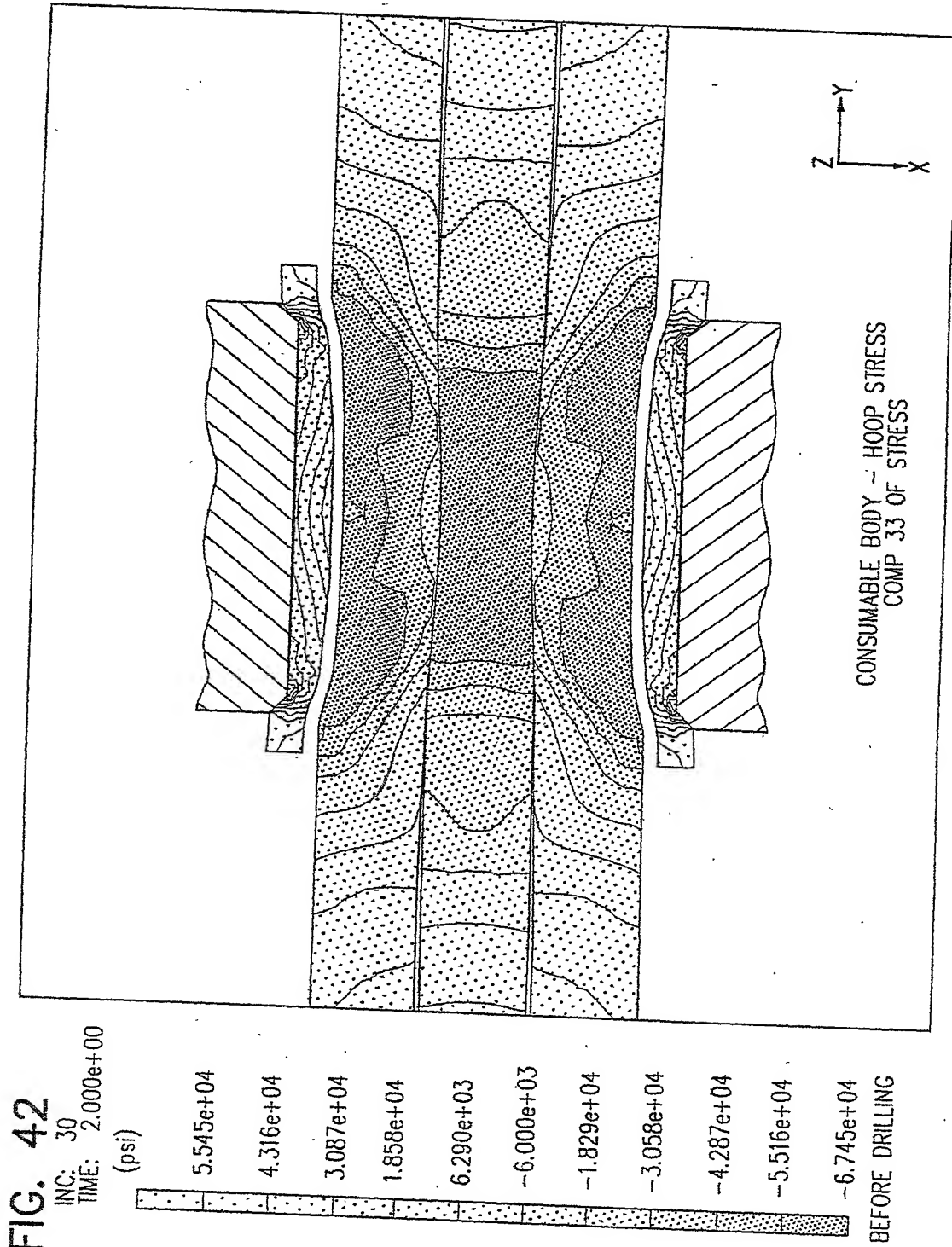


20020707 8049900T

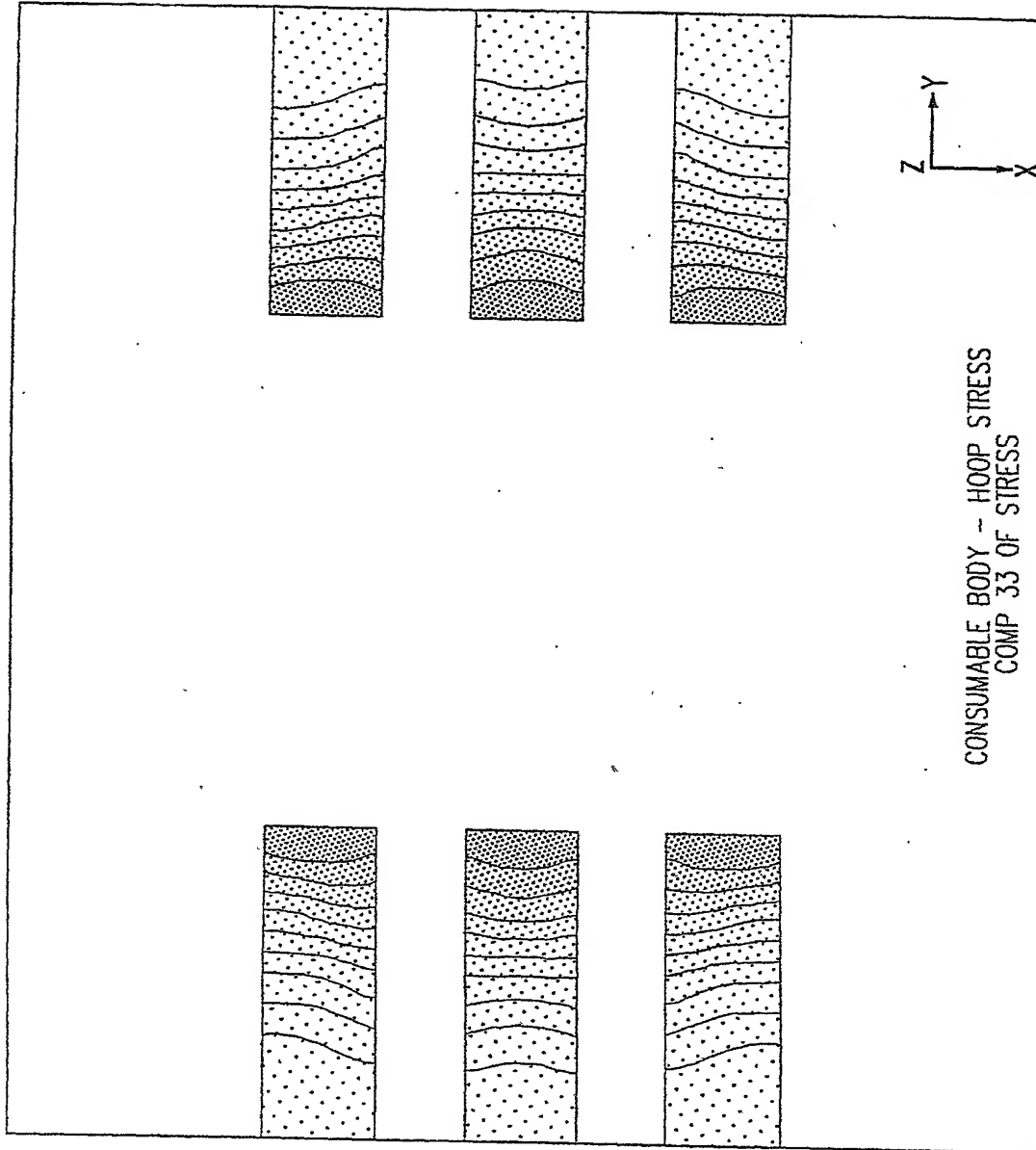
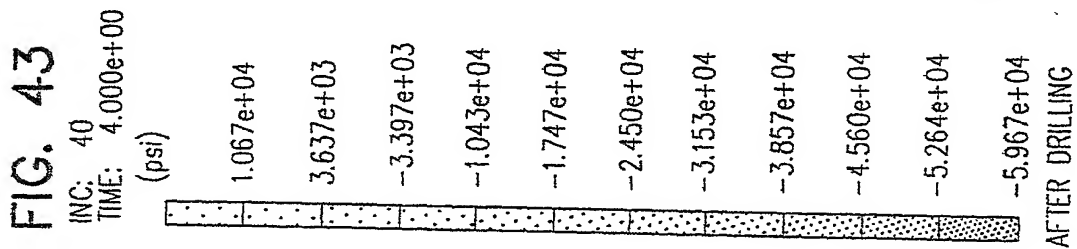
12/50



13/50



14/50

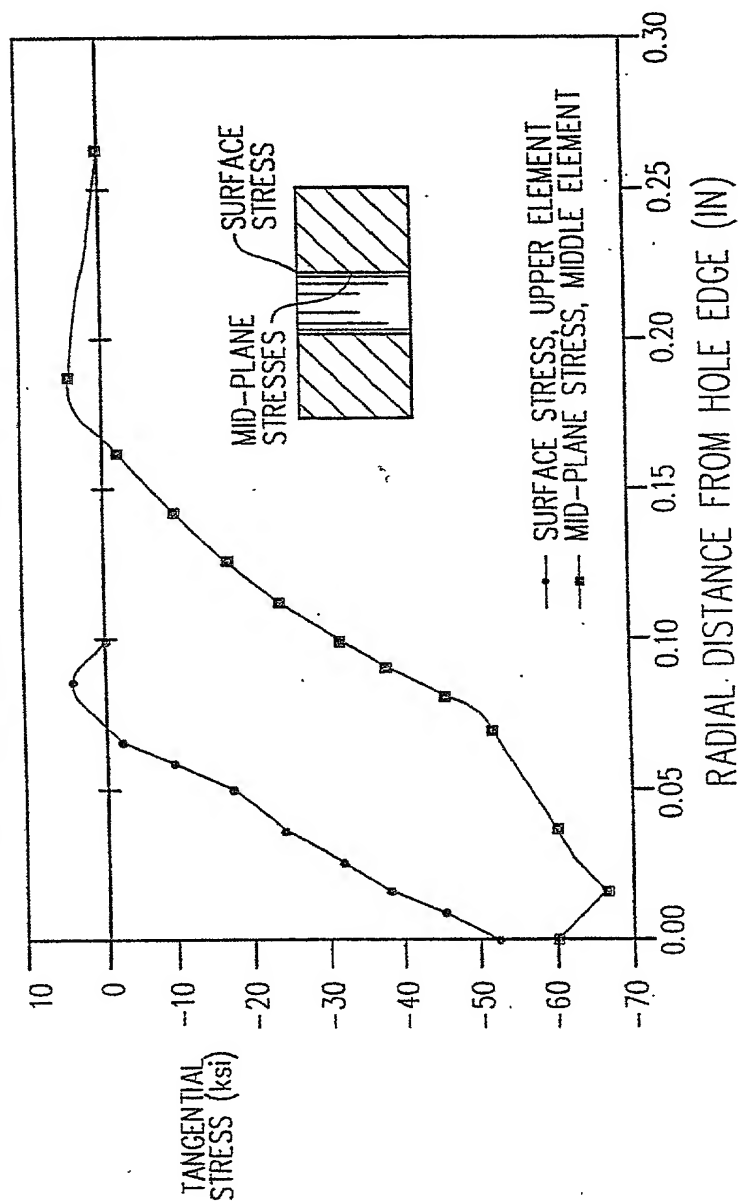


2006FD 80499007

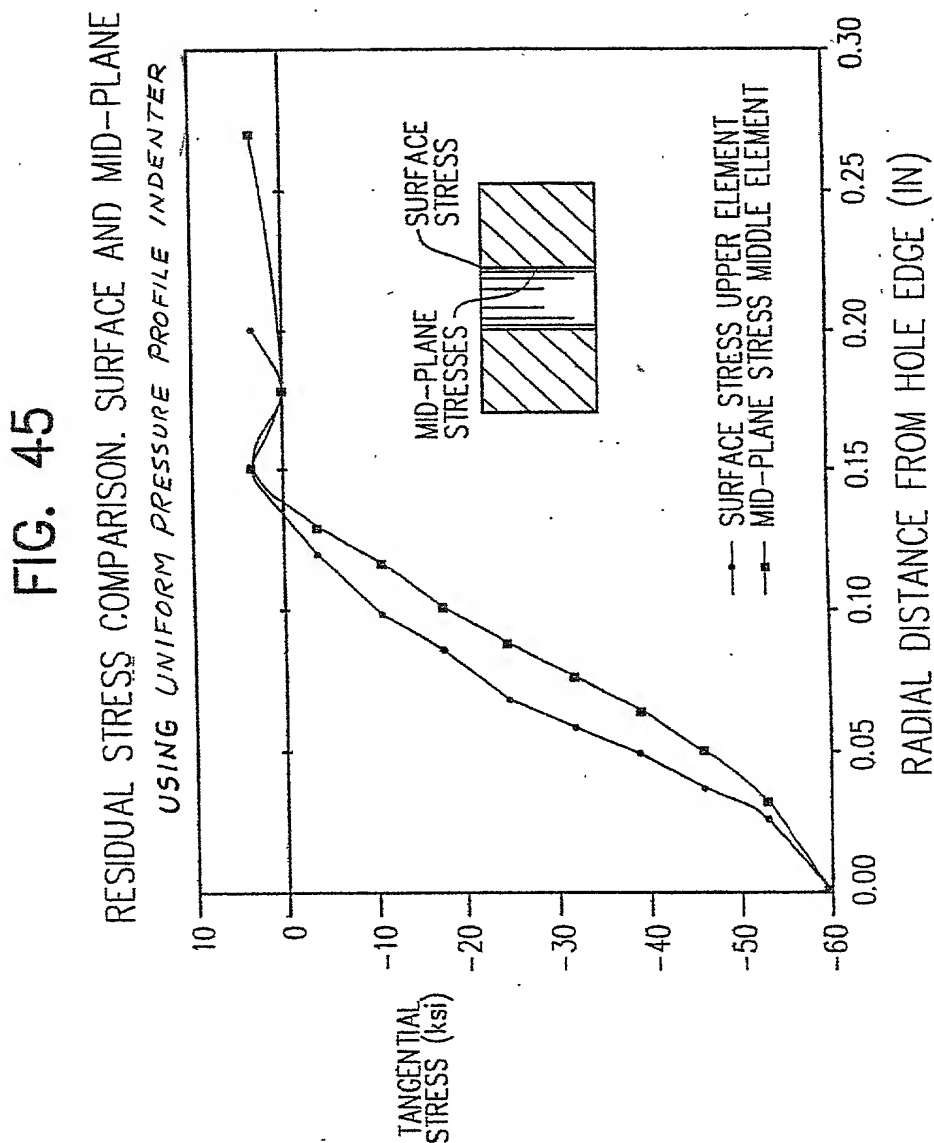
15/50

FIG. 44
 PRIOR ART

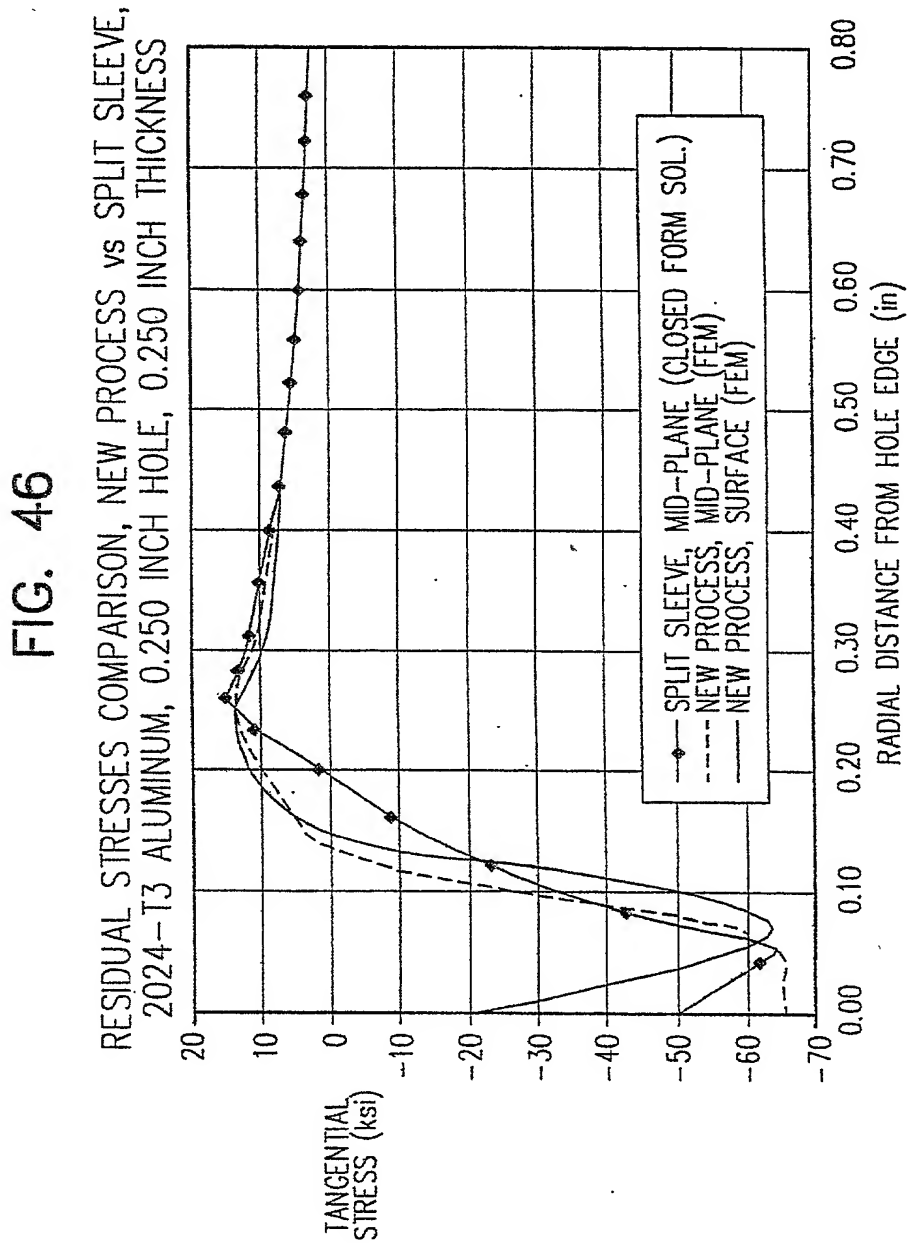
RESIDUAL STRESS COMPARISON, SURFACE AND MID-PLANE
 FLAT BOTTOMED CYLINDRICAL MANDREL



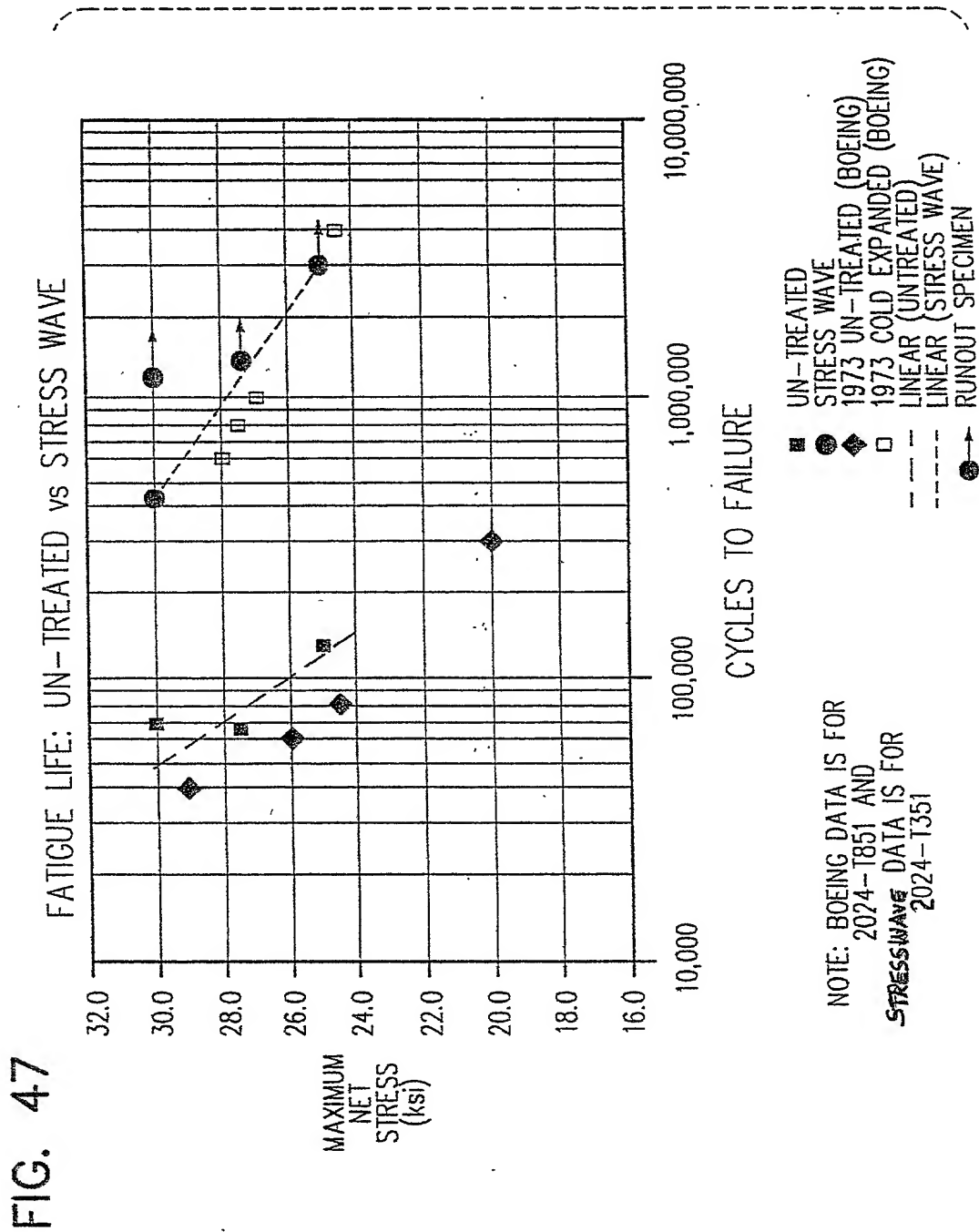
16/50



17/50



18/50



19/50

FIG. 50

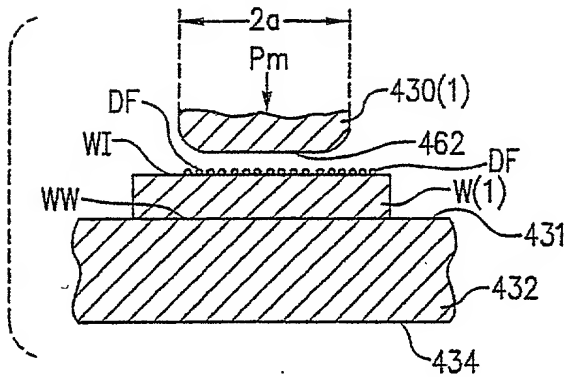


FIG. 52

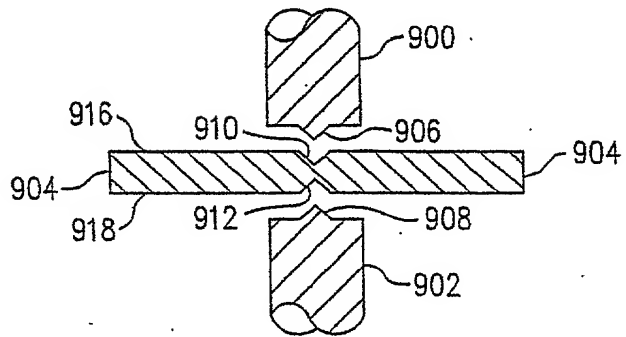


FIG. 53

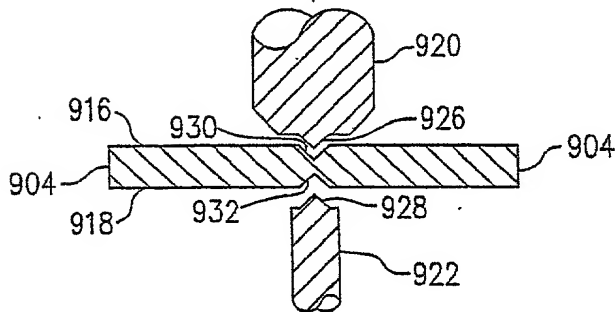
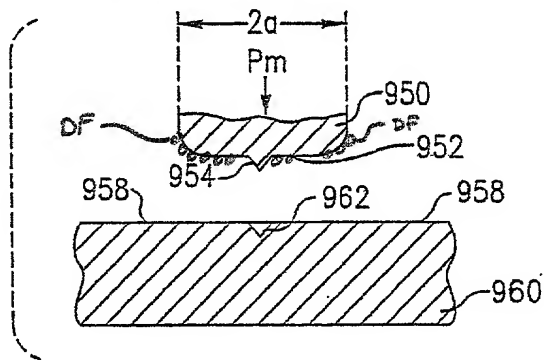


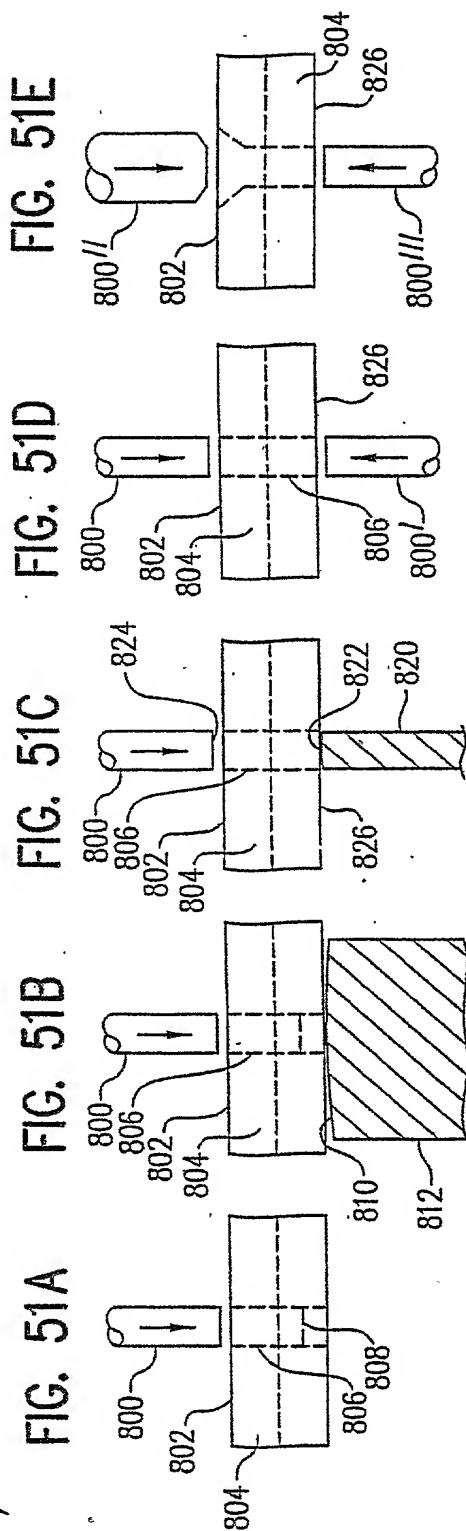
FIG. 54



200810180459001

20/50

FIG. 51



21/50

200EFO" 8049900T

FIG. 55

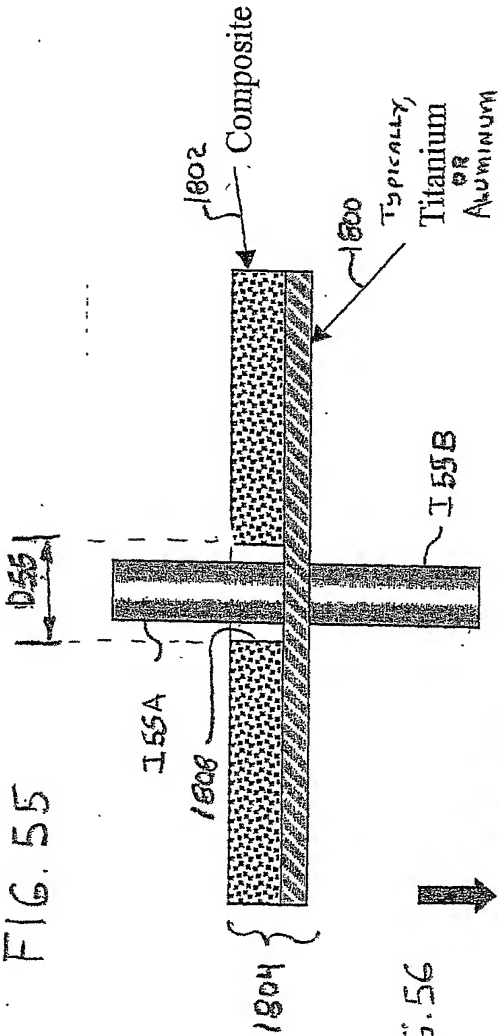
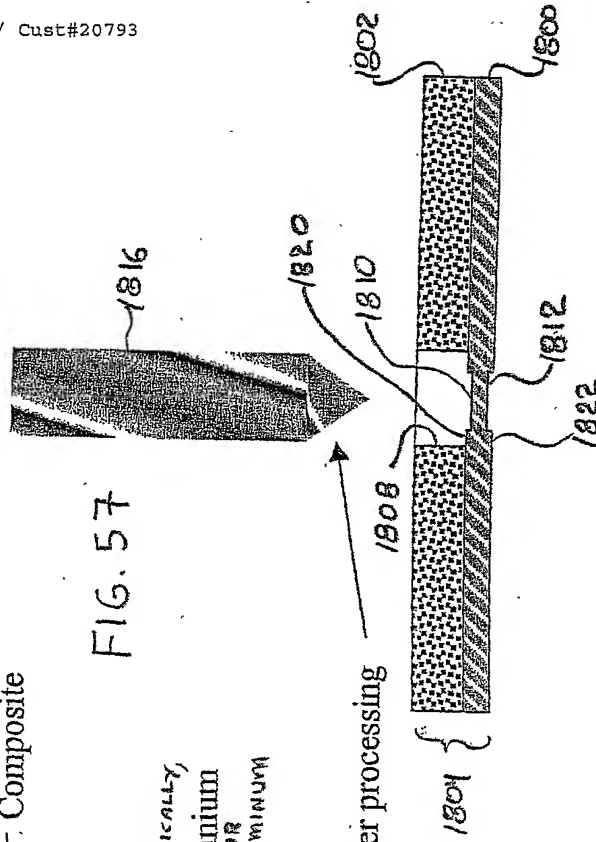


FIG. 57



Stack up is matched drilled after processing

FIG. 56

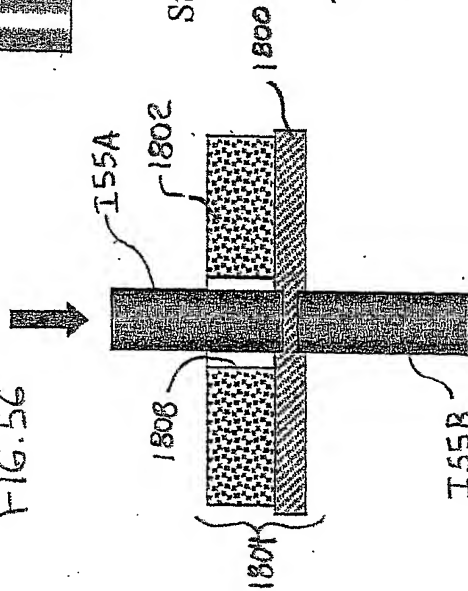
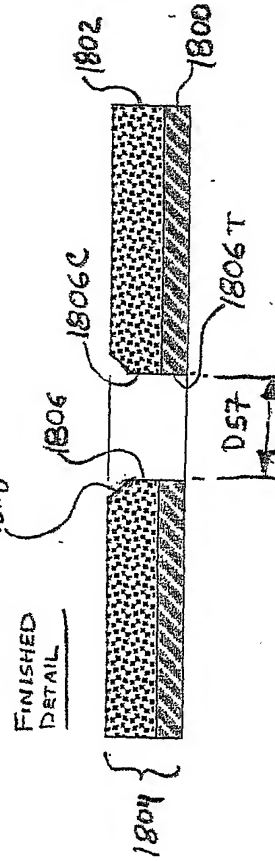


FIG. 58



22/50

200EFO" 80499007

FIG. 59

Temporary (Tack) fastener configuration

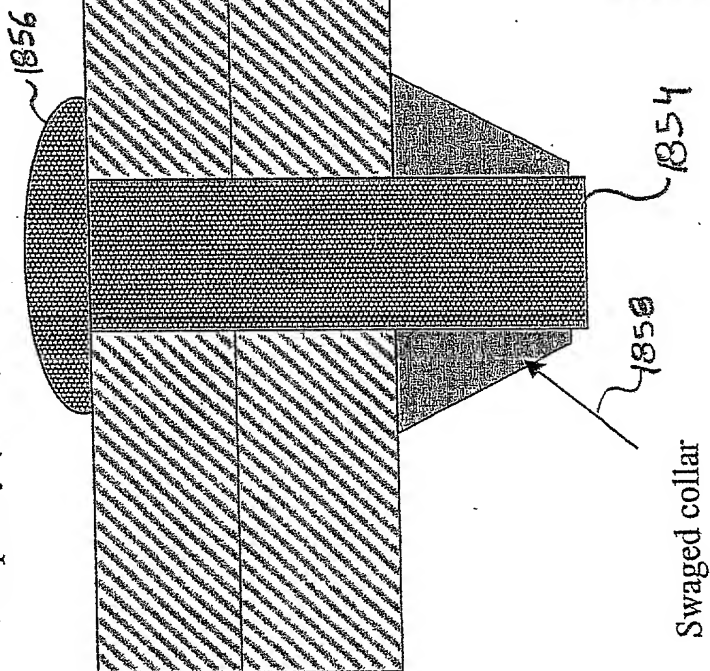
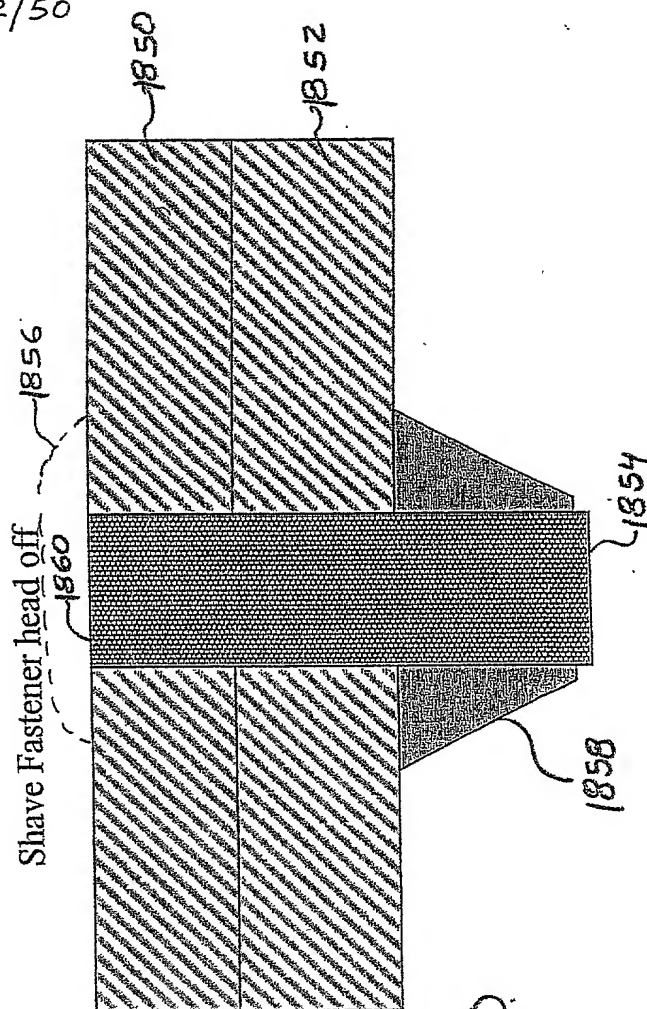


FIG. 60

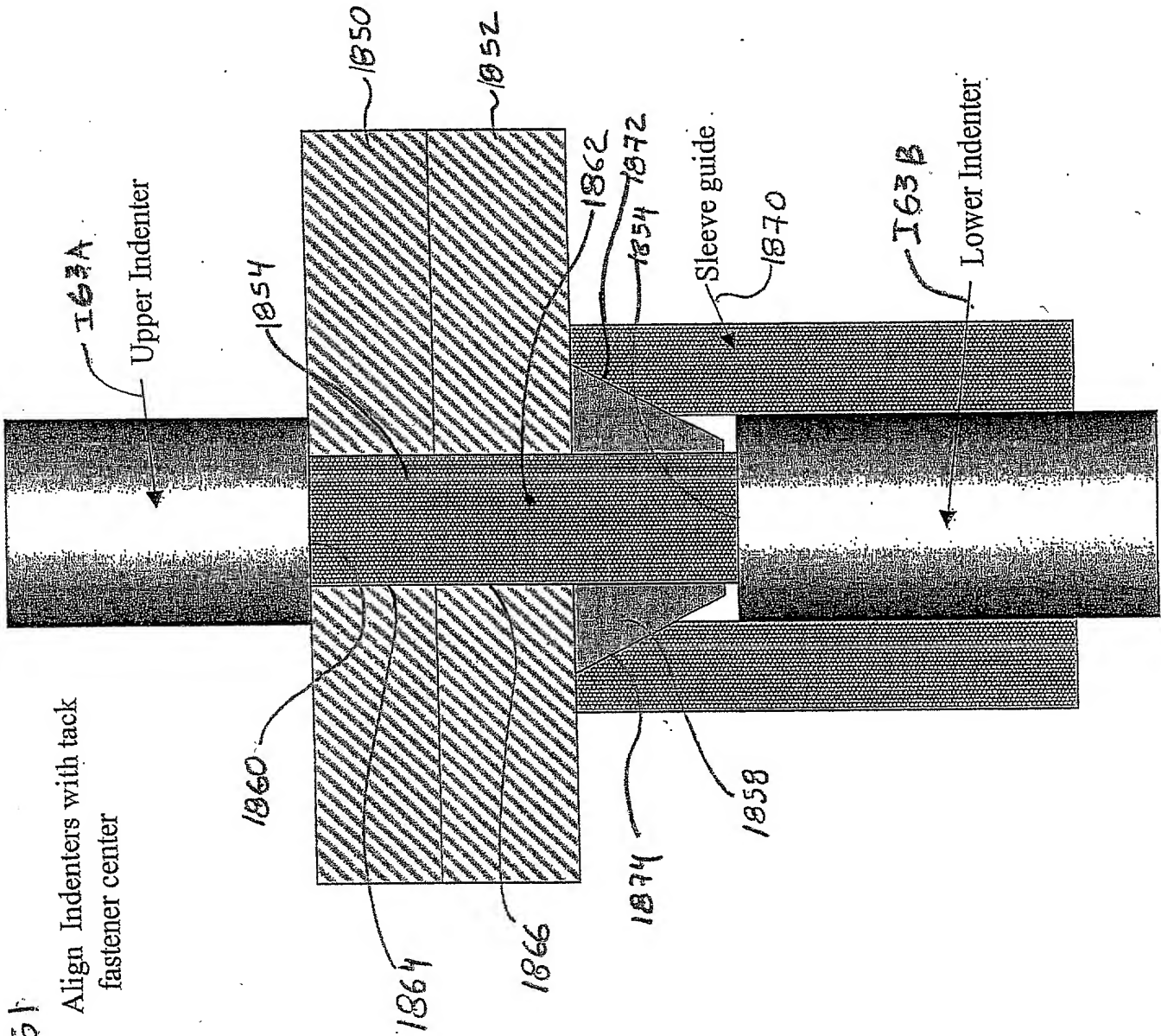


23/50

Parameter	Value	Unit
Temperature	25.0	°C
Pressure	1.0	atm
Flow rate	1.0	L/min
Wavelength	254	nm
Scan rate	1.0	nm/min
Integration time	1.0	s
Resolution	0.5	nm
Detector	Photodiode array	
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	
Flow rate	1.0	mL/min
Injection volume	10	μL
Injection port	1	
Column	Agilent Zorbax SB-C18	
Column length	150	mm
Column ID	4.6	mm
Particle size	5	μm
Mobile phase	Water / Acetonitrile	
Mobile phase A	Water	
Mobile phase B	Acetonitrile	
Gradient	0.1% to 99.9% B over 10 min	

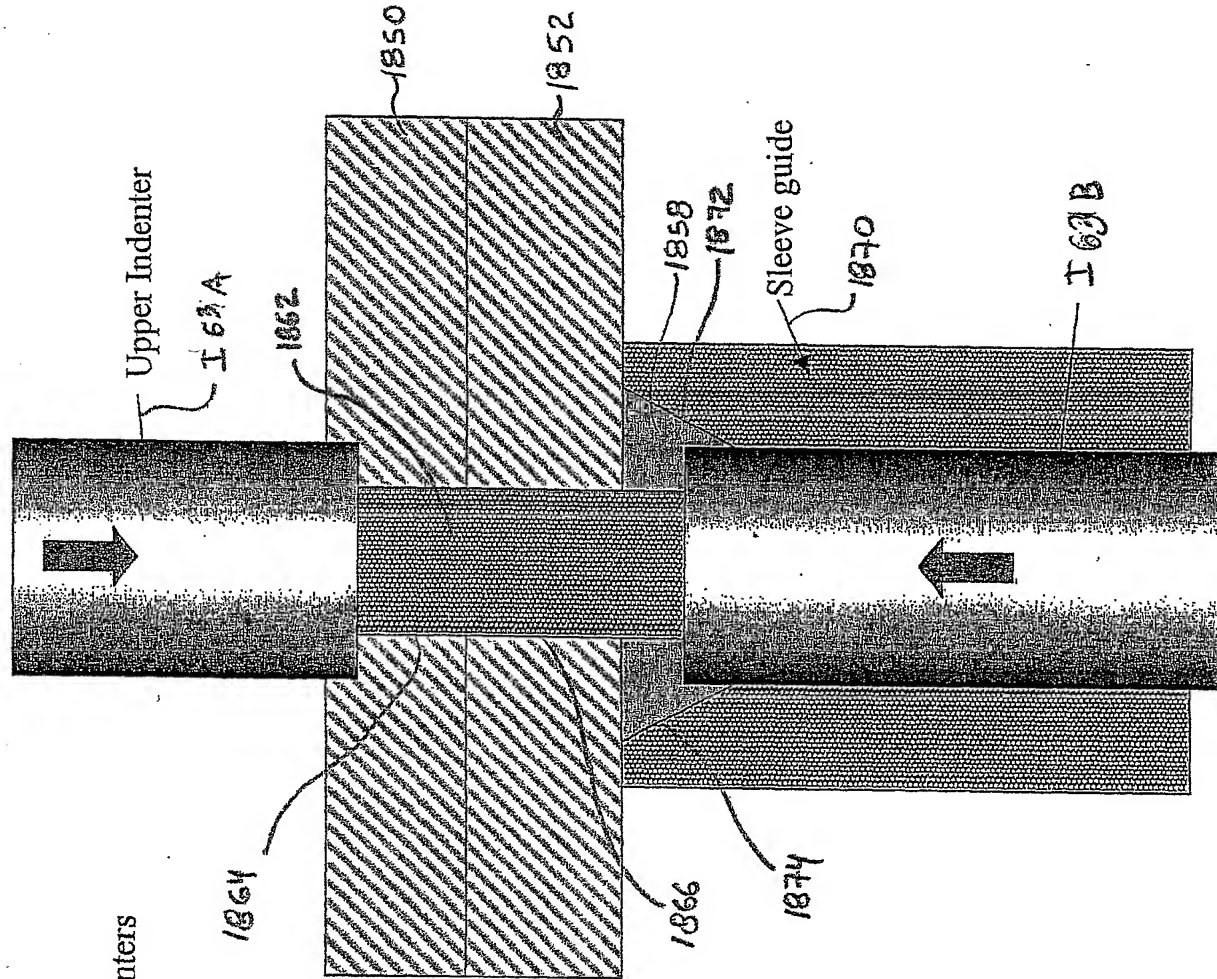
5011

Align Indenters with tack
fastener center



24/50

2006T0" 8049900T

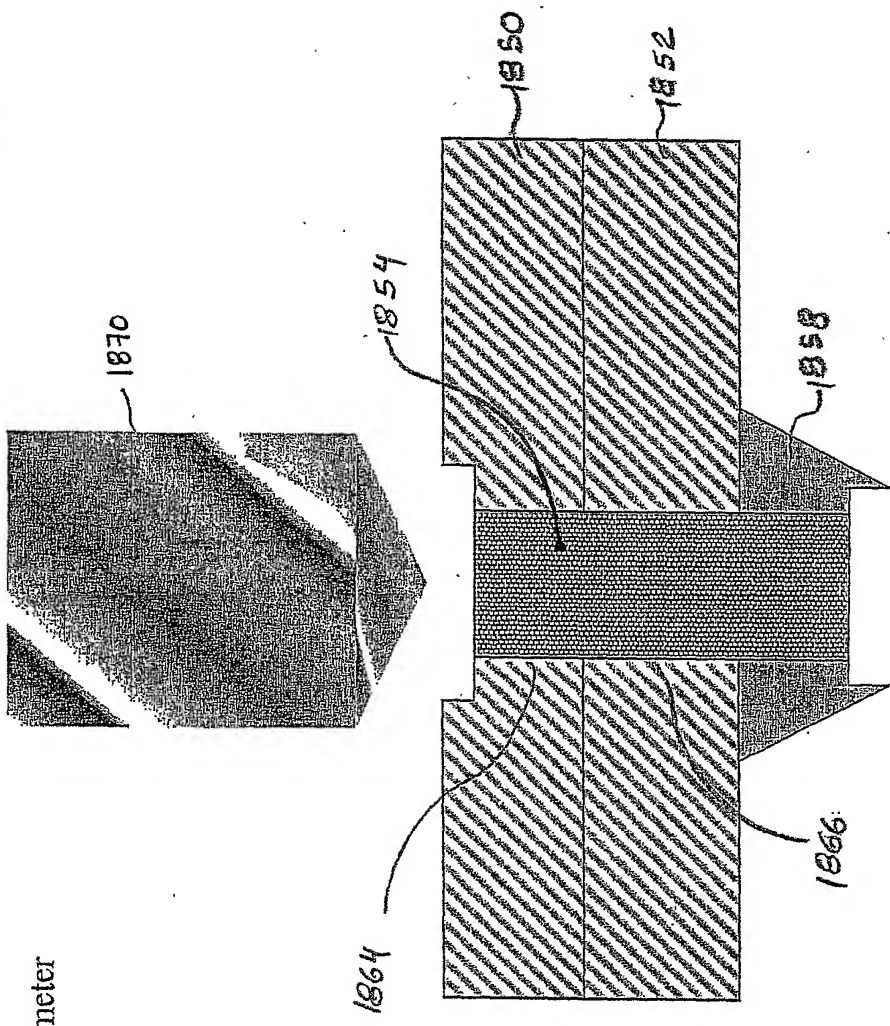


Actuate Indenters

200270" 8049900T

FIG. 63

Drill to bolt diameter

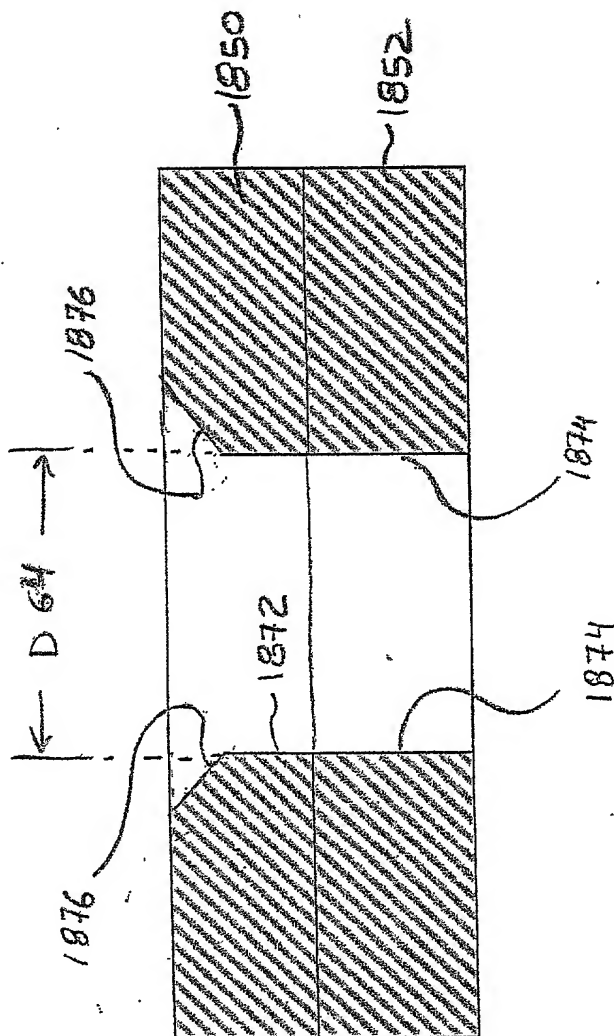


25/50

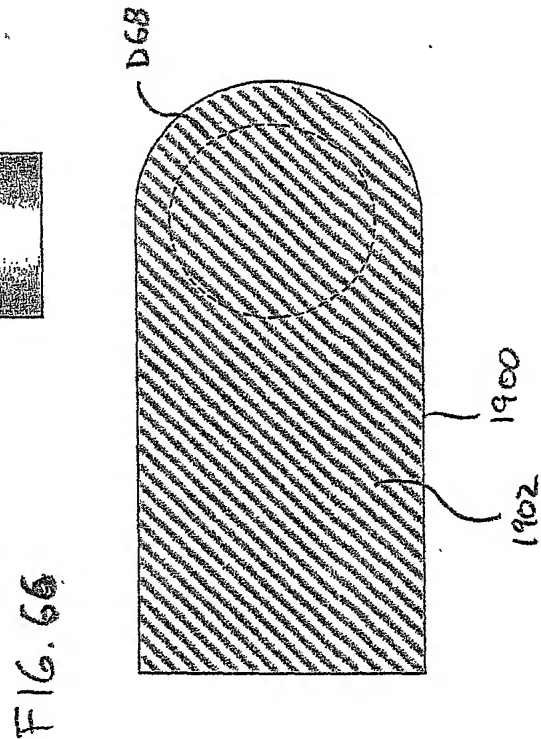
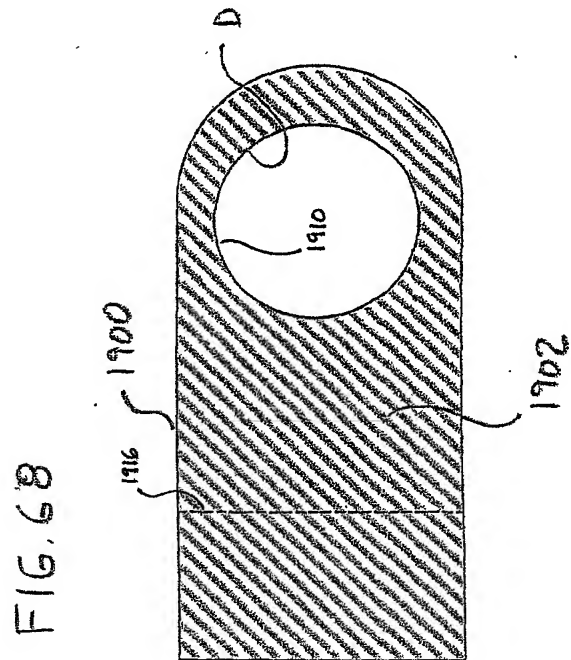
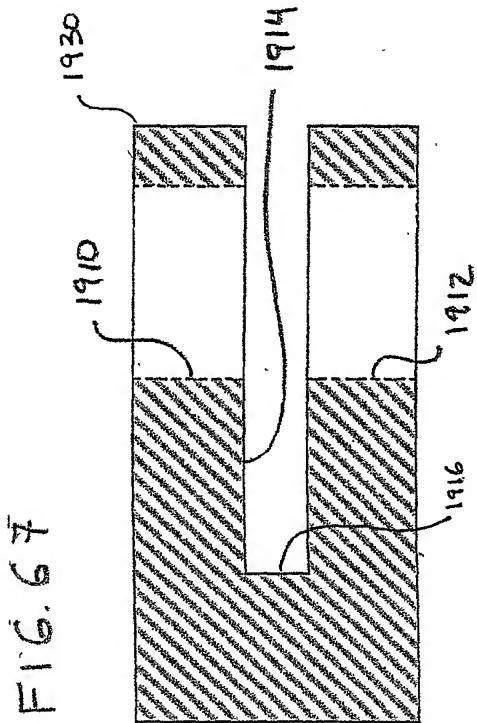
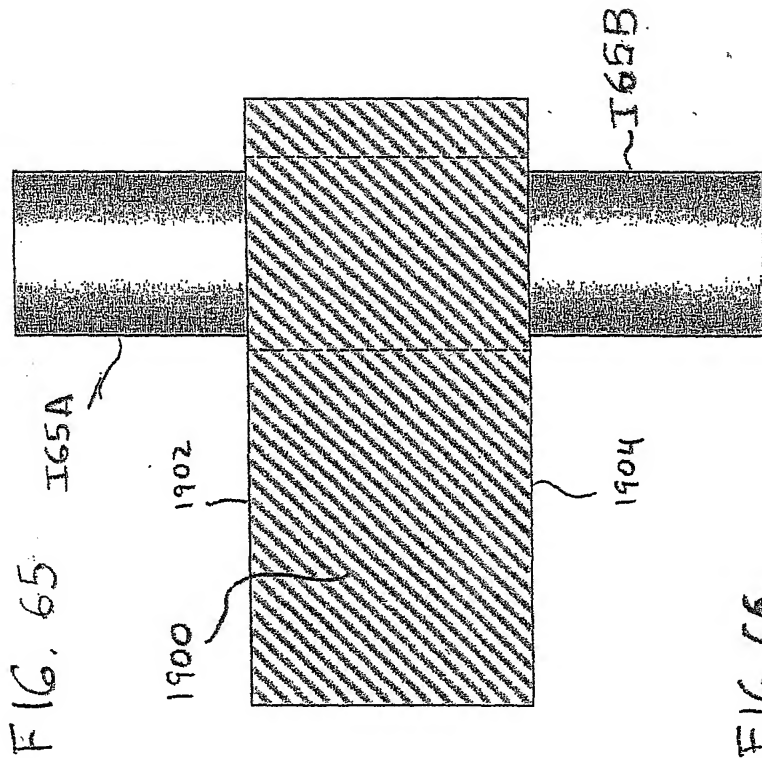
26/50

FIG. 64

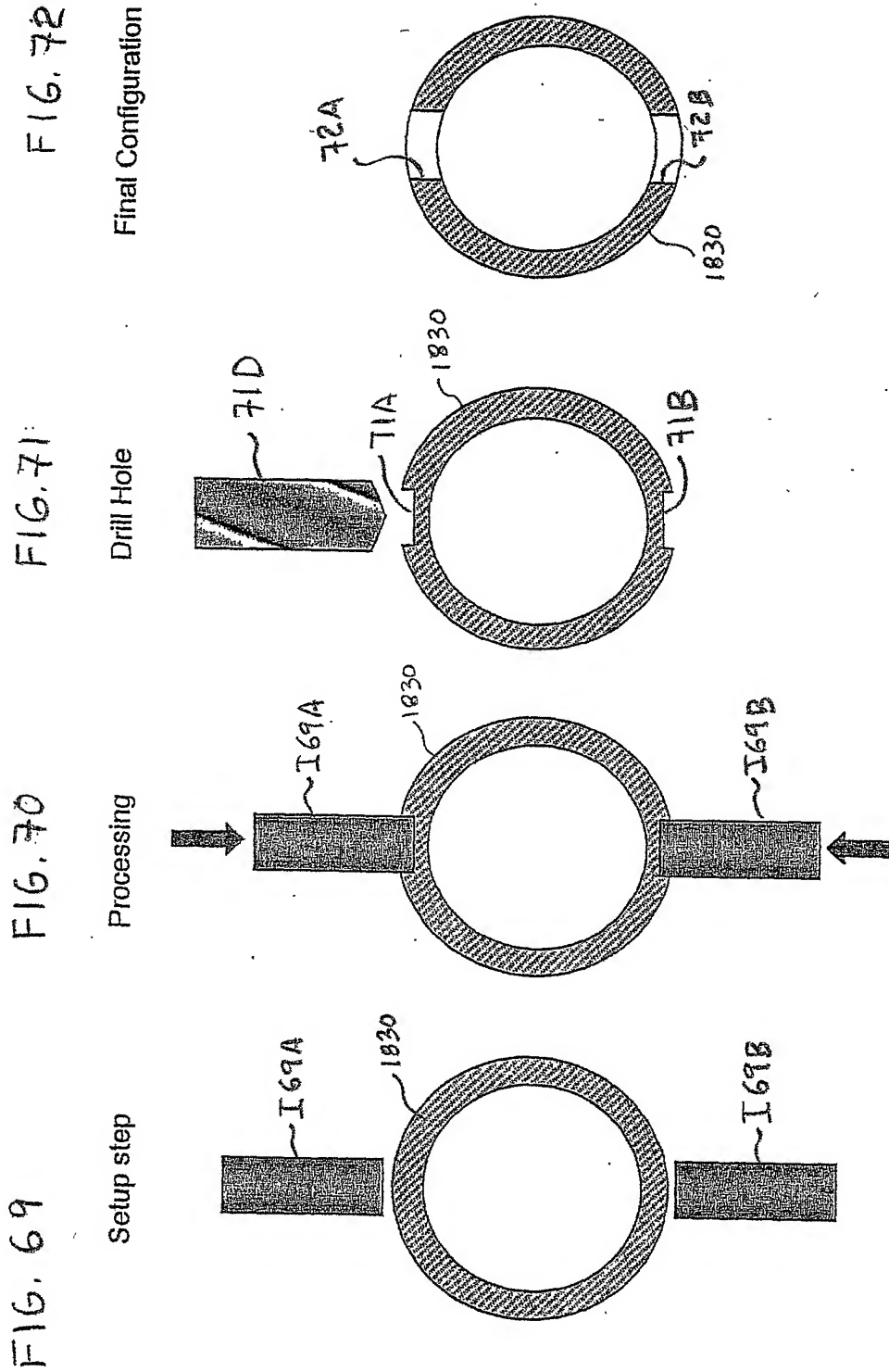
Finished treated hole



27/50



28/50



Treatment of a tubular bar without internal support

FIG. 73

Cross-Sectional view of processing step

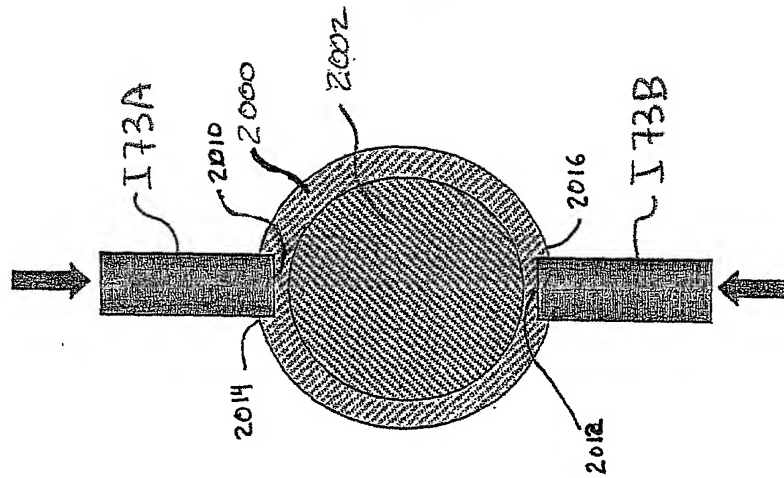
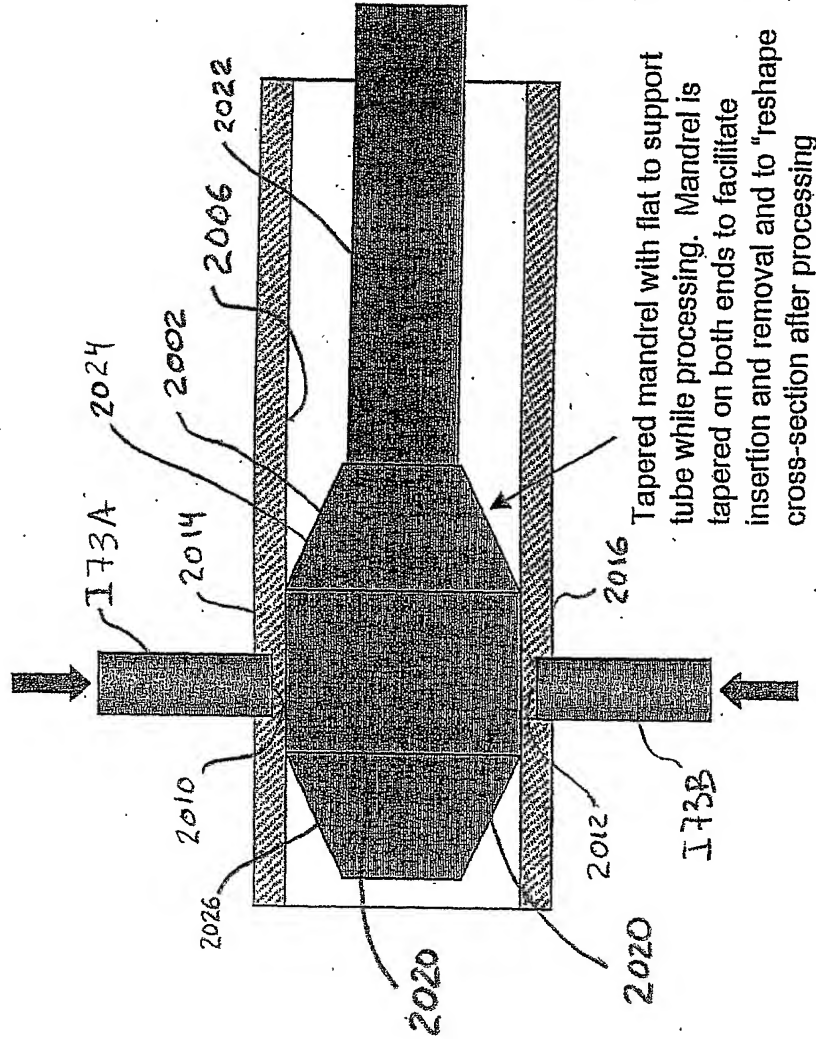


FIG. 74

Longitudinal cross-sectional view of processing step



Treatment of a tubular bar with internal support

Cross section of hollow tube treated with indenter end shape that conforms to tube diameter

FIG. 75

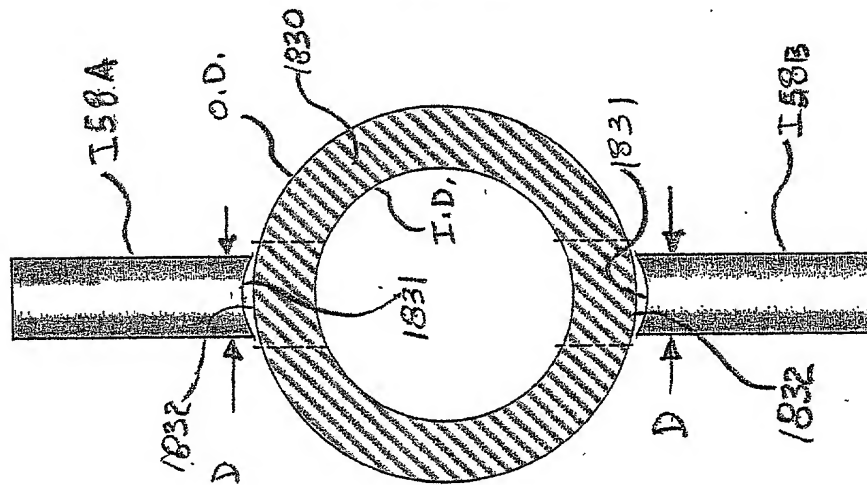
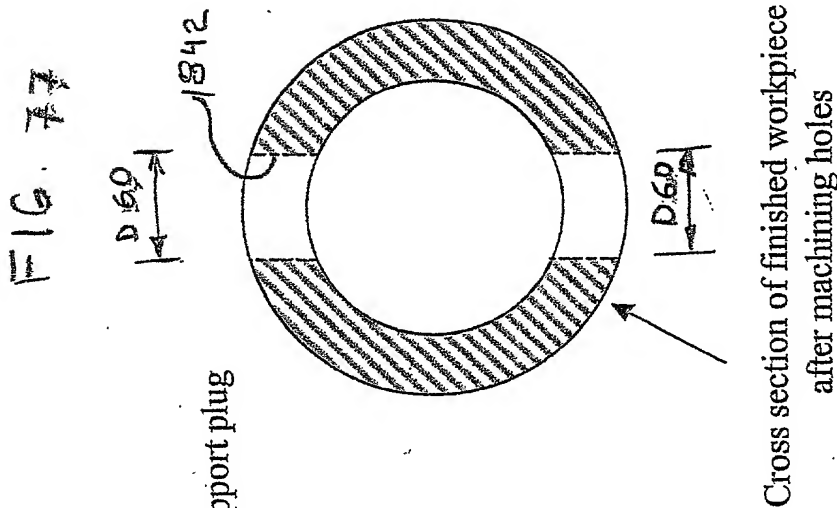
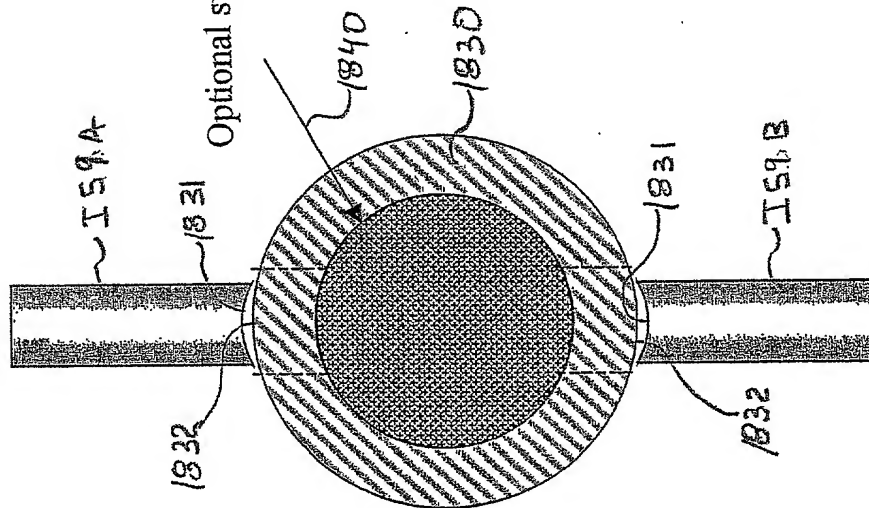


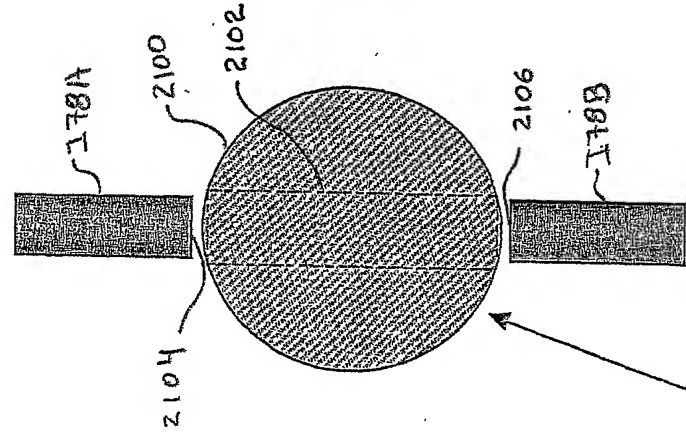
FIG. 76



20020701 8049900T

FIG. 78

Setup step



Cross section of round bar

FIG. 79

Processing

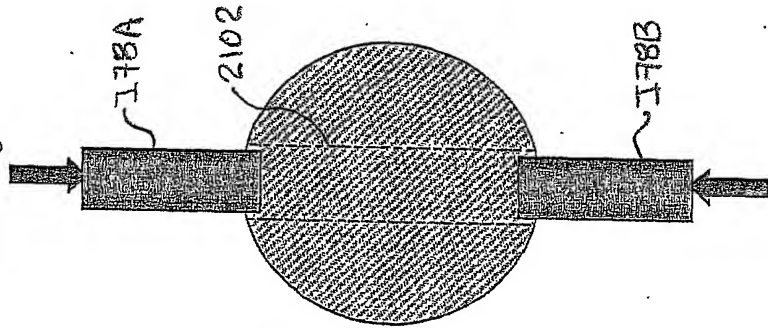


FIG. 80

Drill Hole

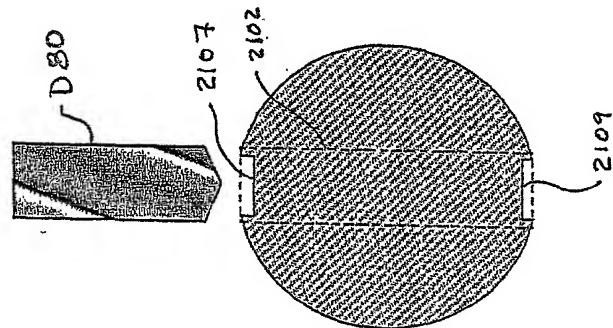


FIG. 81

Final Configurations

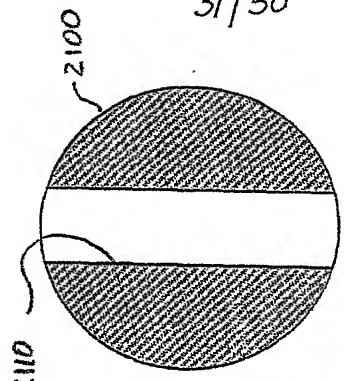
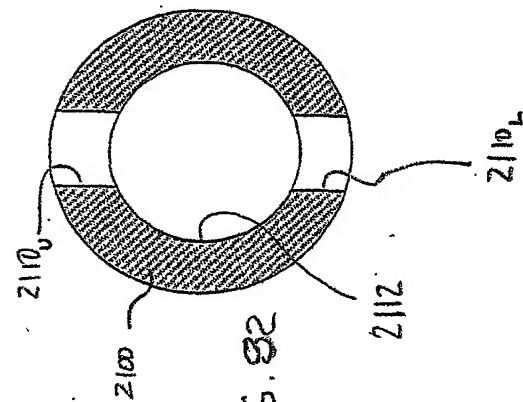


FIG. 82



Treatment of a solid bar

33/50

FIG. 88

Setup step

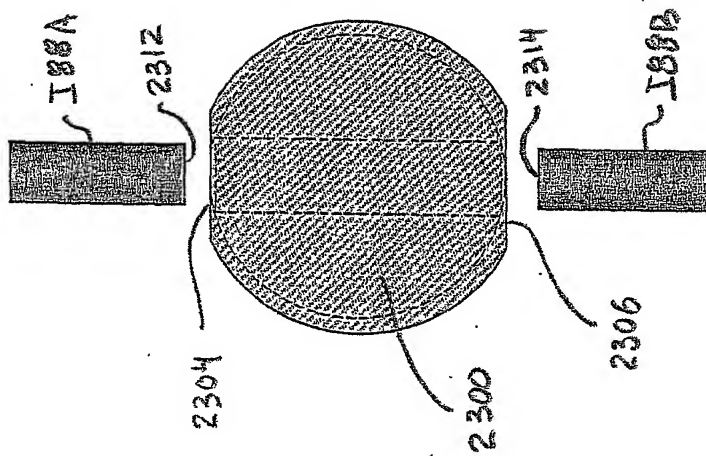


FIG. 89

Processing

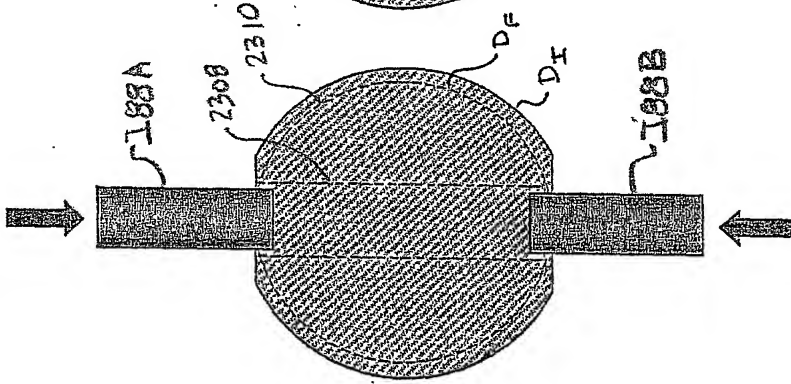


FIG. 90

Drill Hole

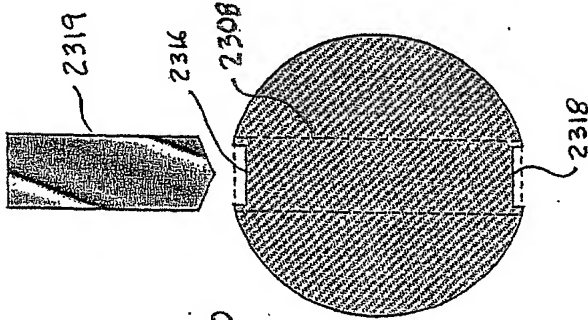


FIG. 91

Final Configurations

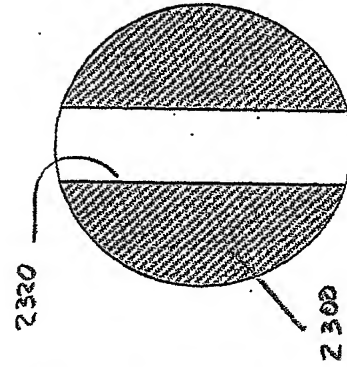
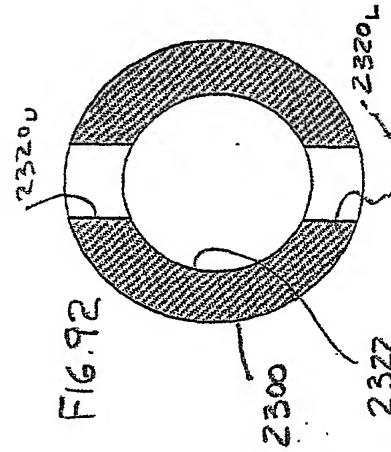


FIG. 92



Treatment of an initially oversized solid bar with
 opposing "flats" to facilitate treatment

FIG. 93

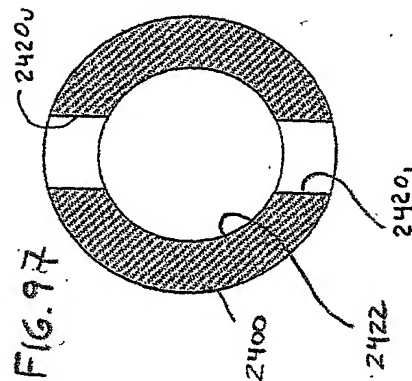
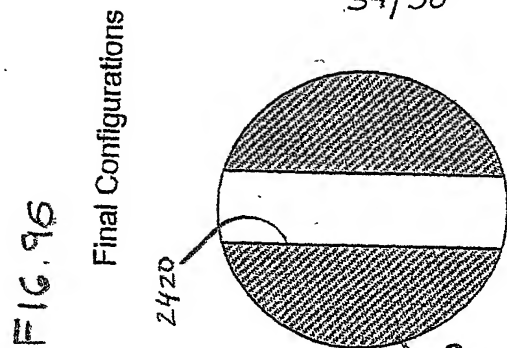
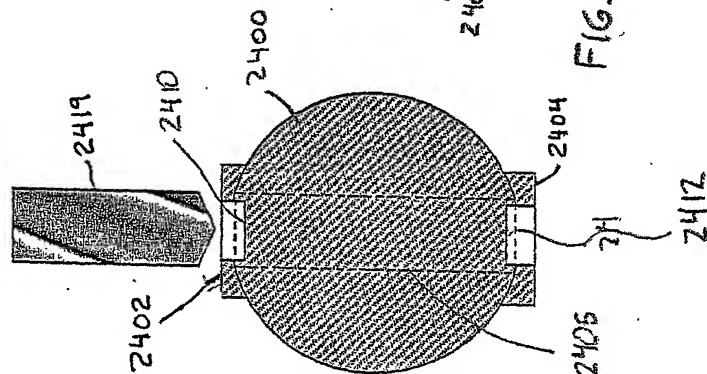
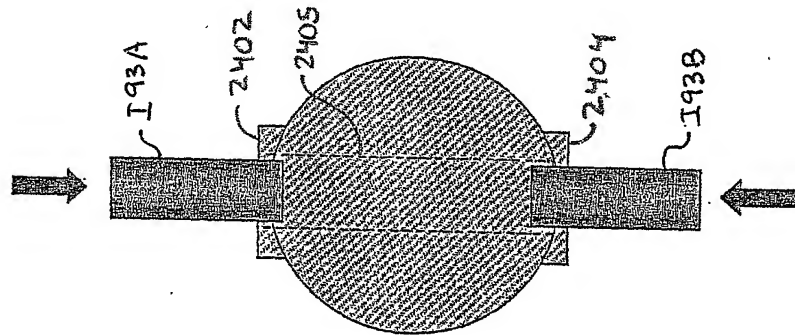
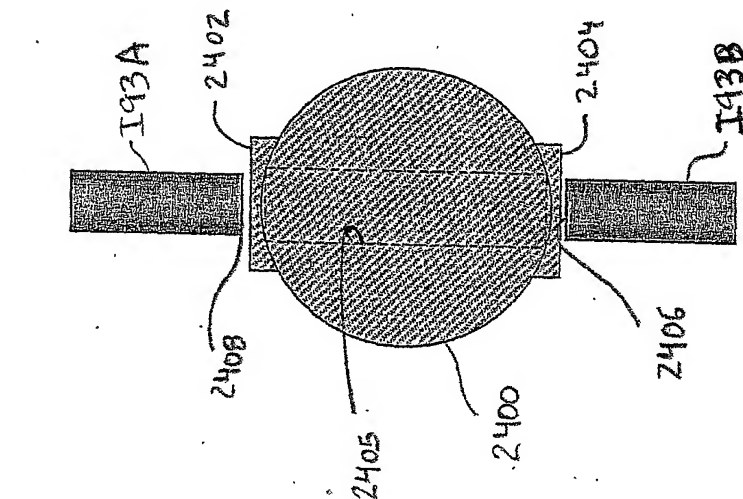
Setup step

FIG. 94

Processing

FIG. 95

Drill Hole



Treatment of a solid bar with milled or integral "flats" to facilitate the process

FIG. 98

Process setup step

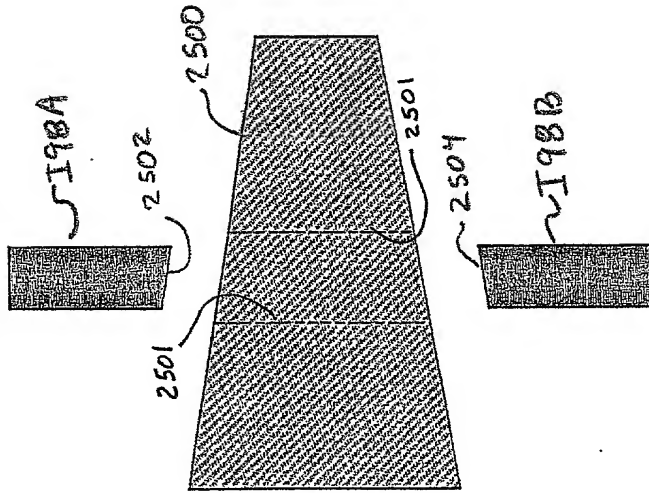
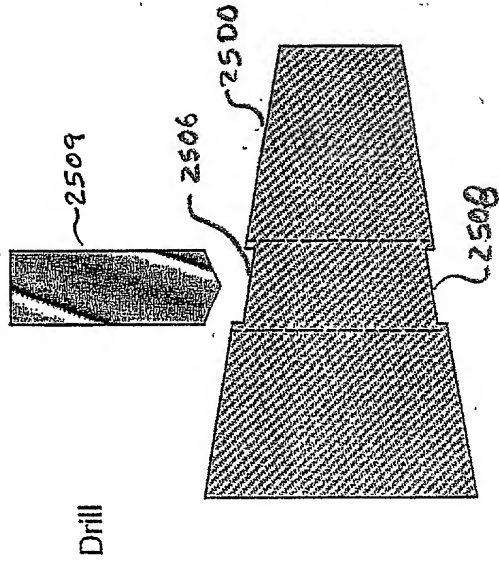


FIG. 99



35/50

Final configuration

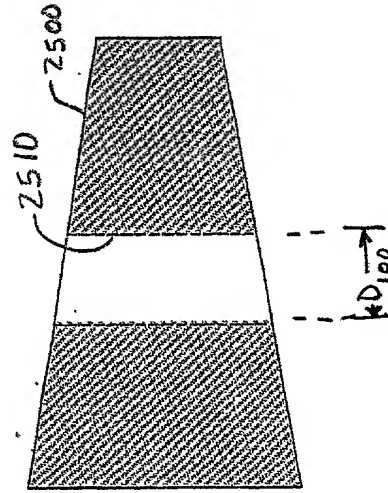


FIG. 100

Treatment of a structure with two tapered surfaces

FIG. 101

Process setup step

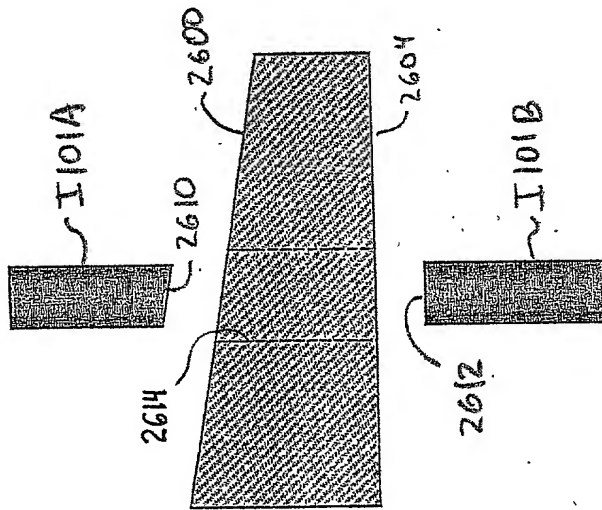


FIG. 101A

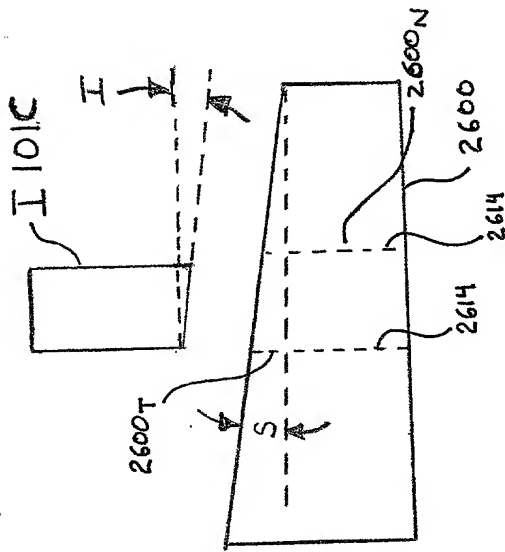
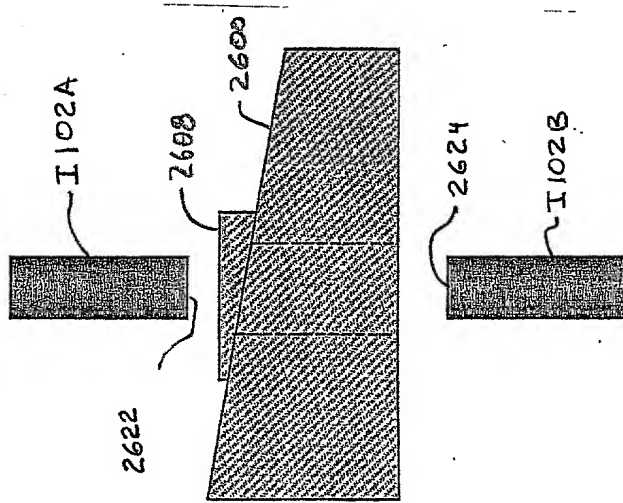


FIG. 102



36/50

Final configuration

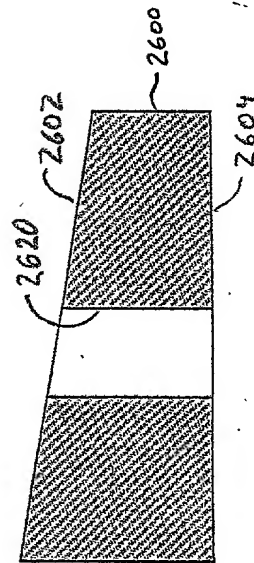


FIG. 103

FIG. 104

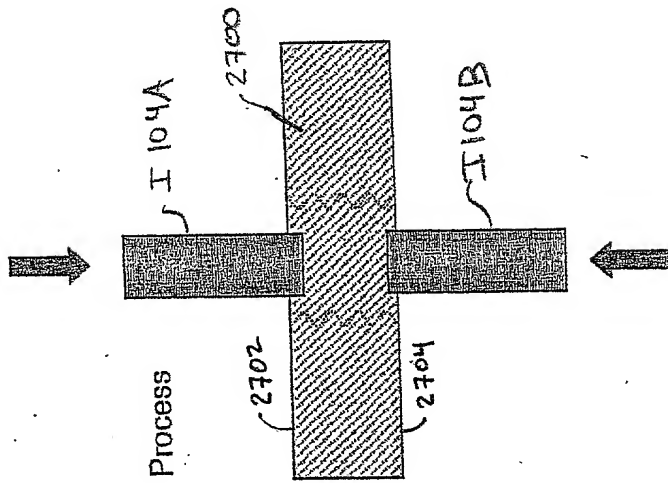


FIG. 105

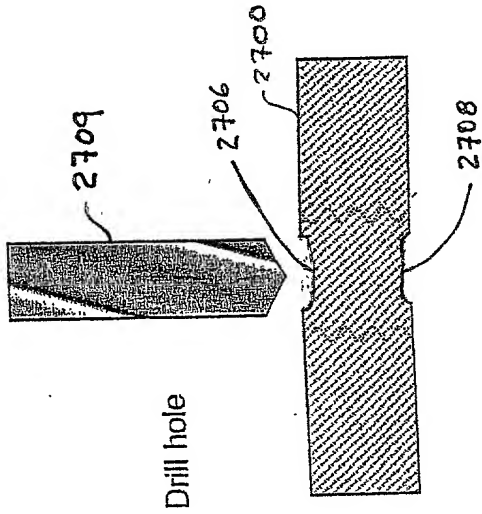
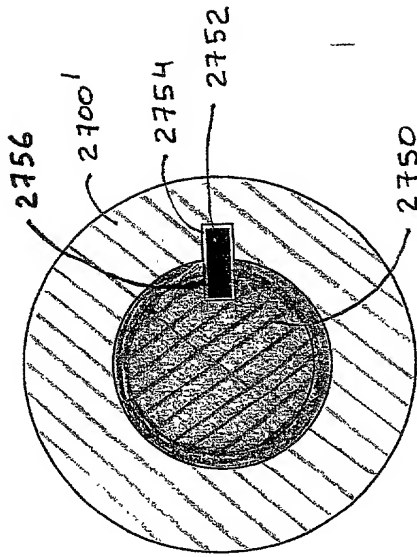


FIG. 106A



Assembled Connection

FIG. 106B

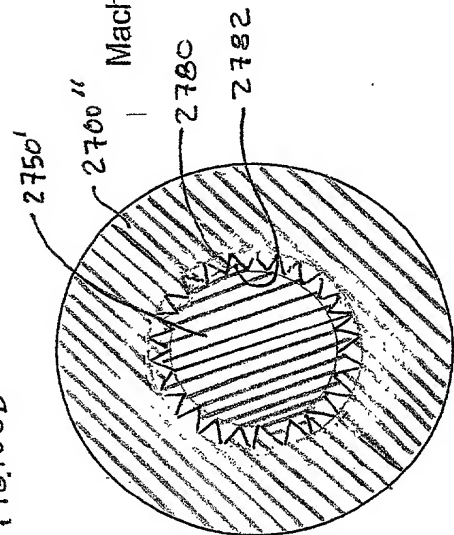


FIG. 106

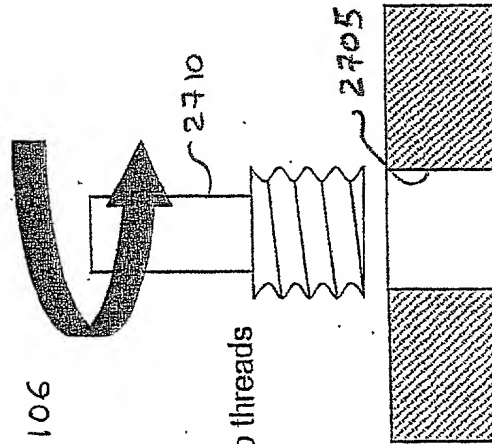


FIG. 107

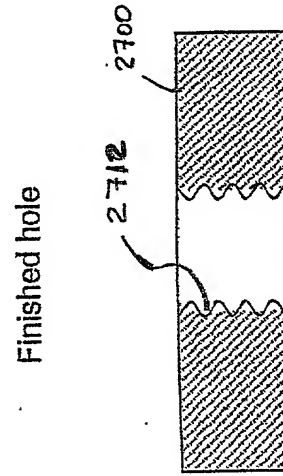
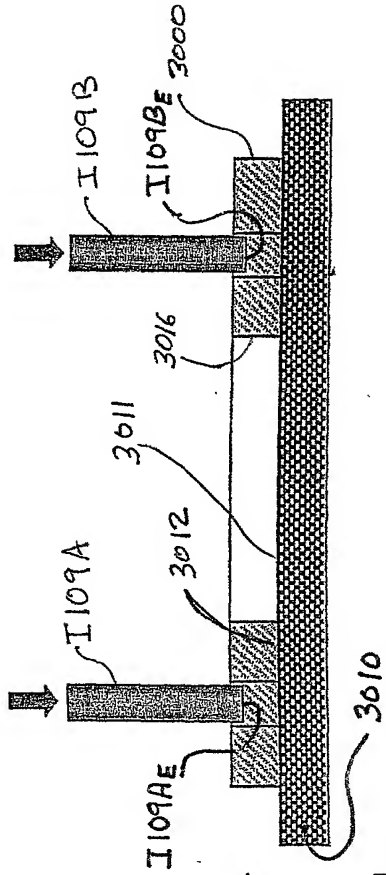
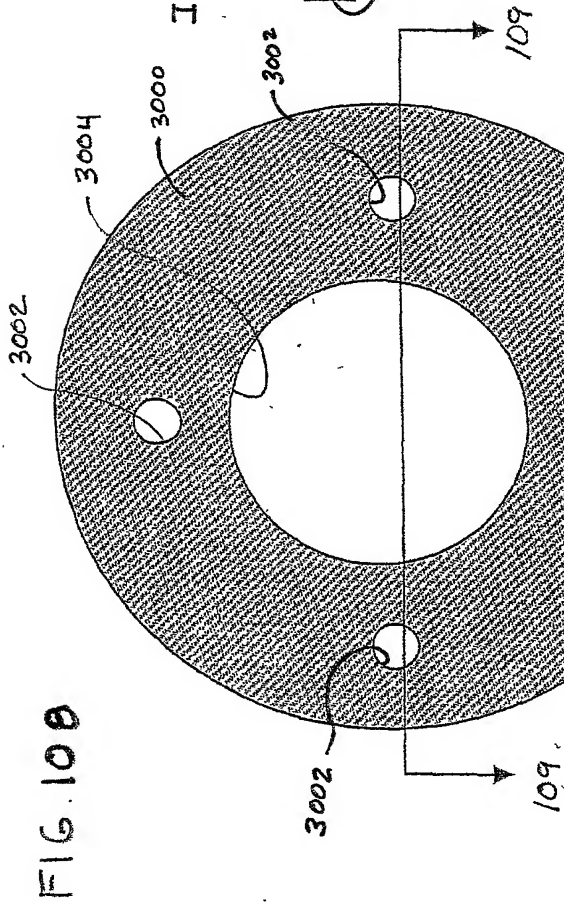


FIG. 109



38/50

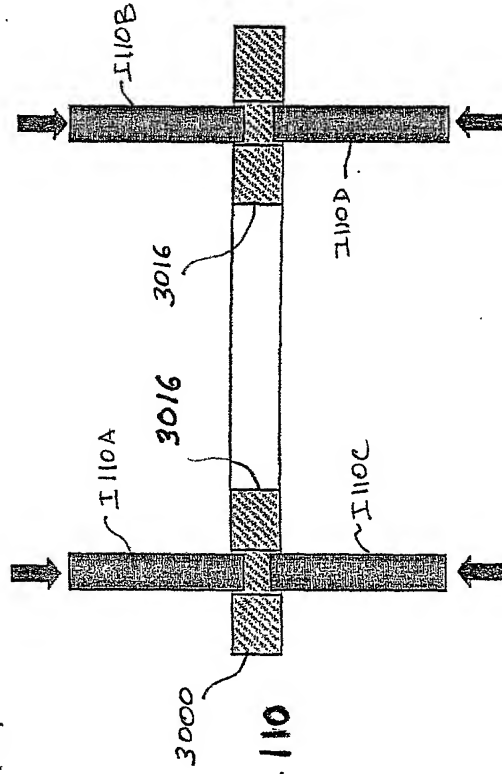


FIG. 110

Simultaneous or sequential treatment of a pattern
 of holes, one-sided or two-sided

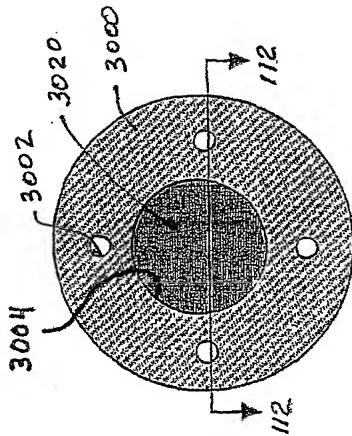


FIG. 111

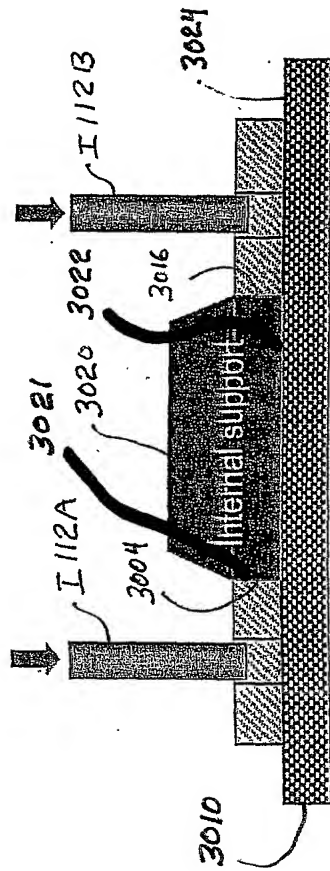


FIG. 113

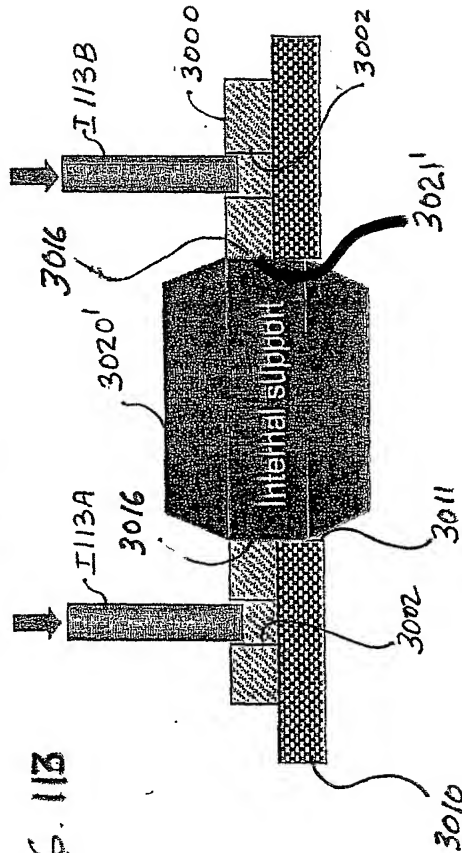
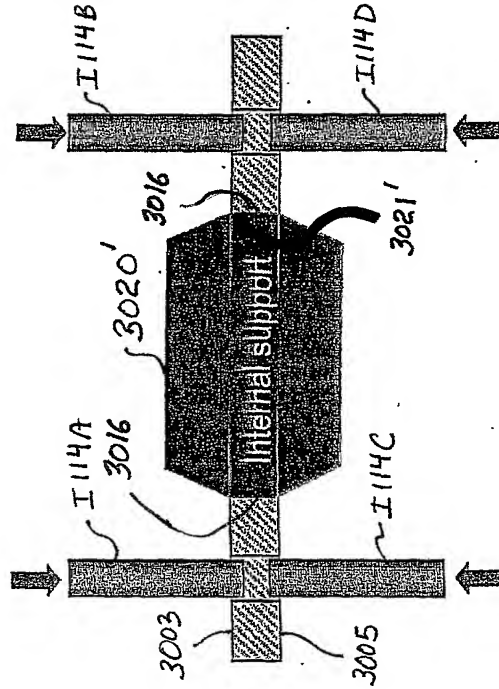


FIG. 114

FIG. 115



Simultaneous or sequential treatment of a pattern of holes, one-sided or two-sided with internal support

FIG. 118

Machine large hole diameter

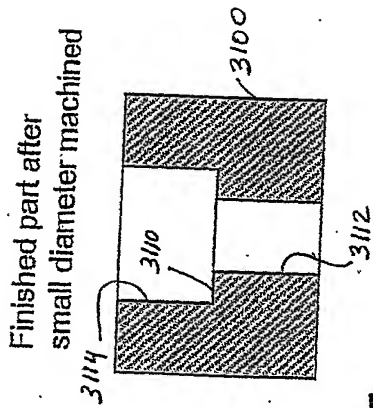


FIG. 115

Process large diameter

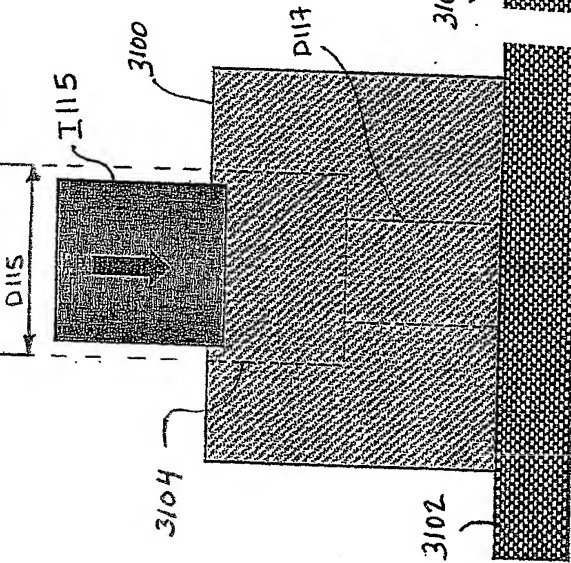
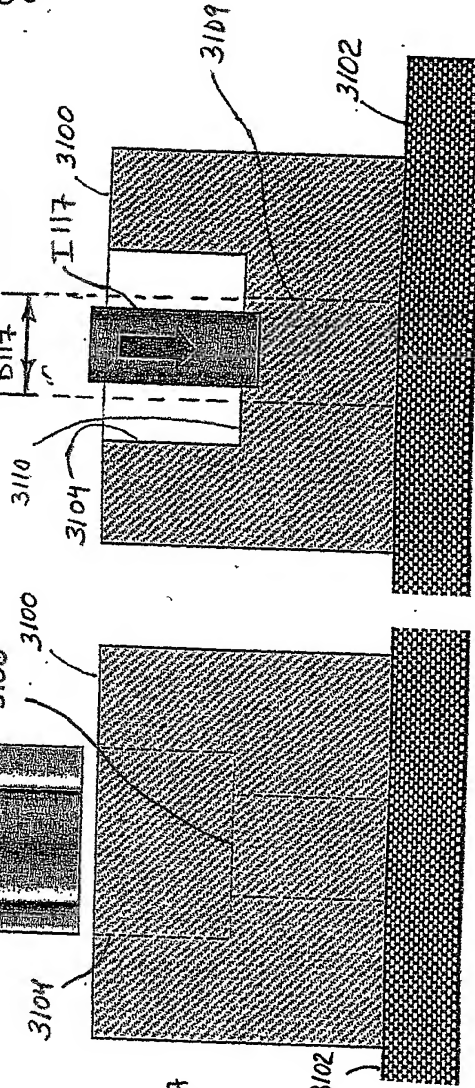


FIG. 117

Process small diameter



Treatment of a stepped hole

41/50

FIG. 120

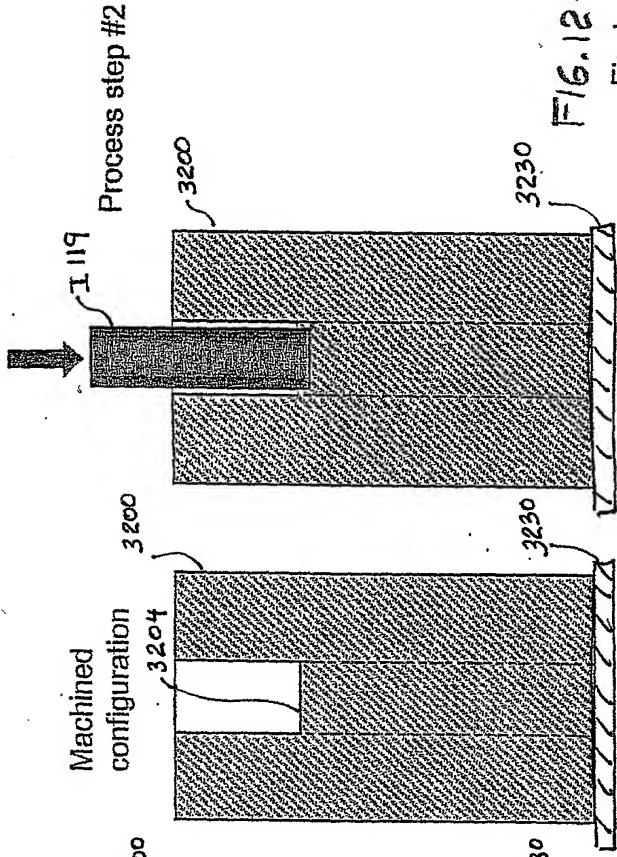
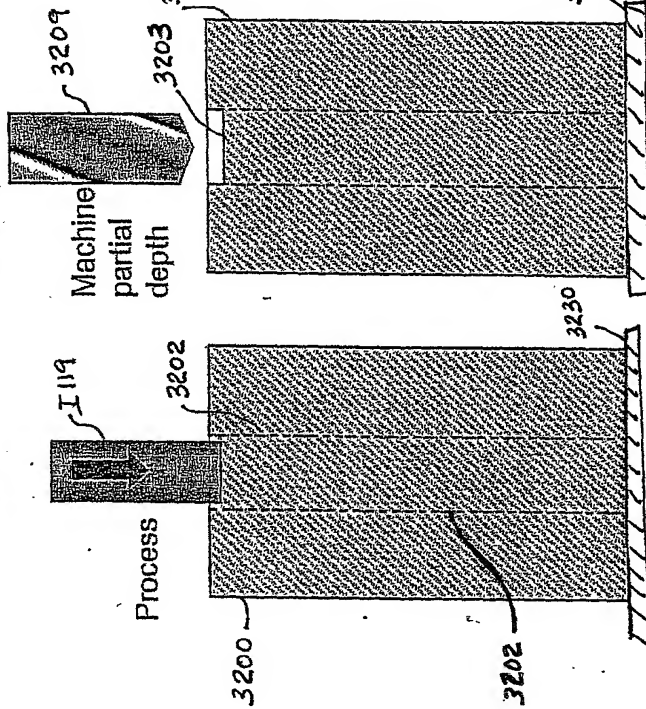


FIG. 122

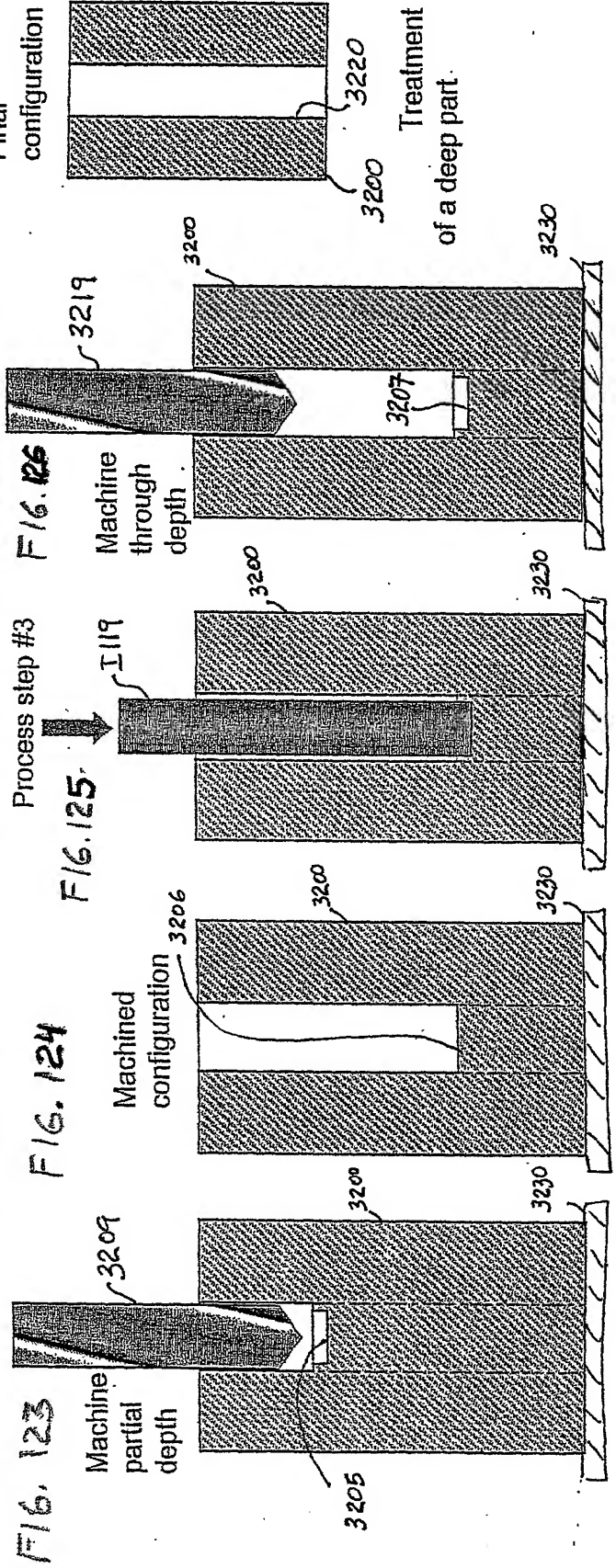


FIG. 120

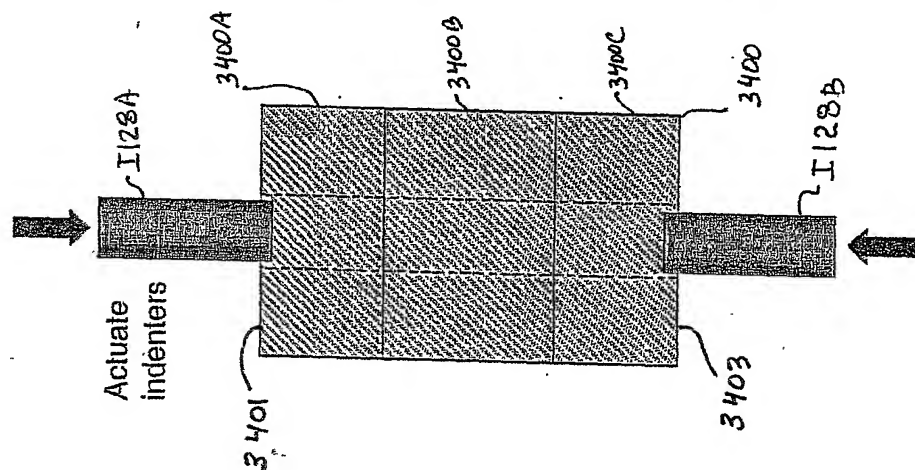


FIG. 129

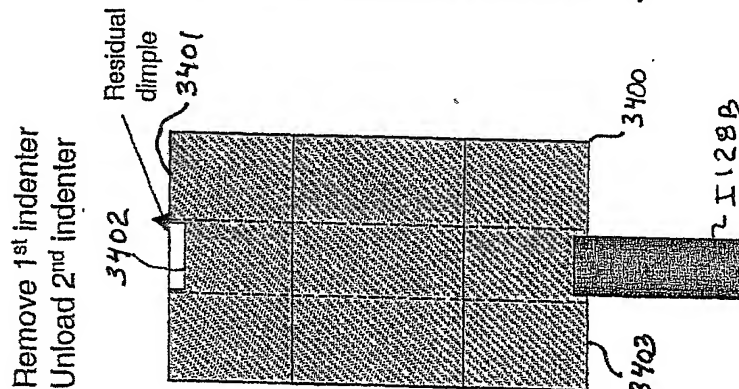


FIG. 130
 Setup step.
 For machining
 Partial depth

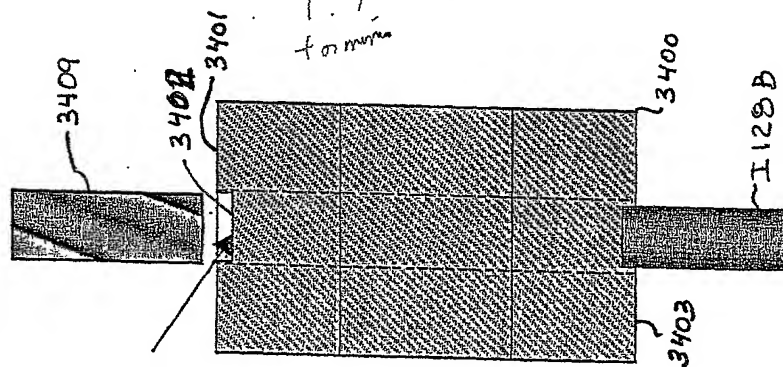
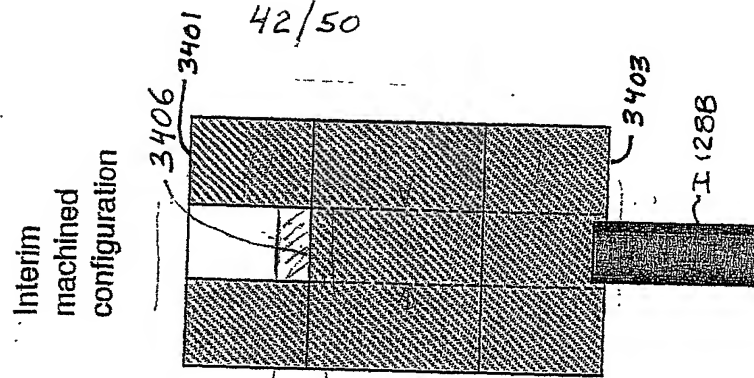


FIG. 131



200610" 8049900T

43/50

FIG. 132

Process step #2
 Actuate indenters

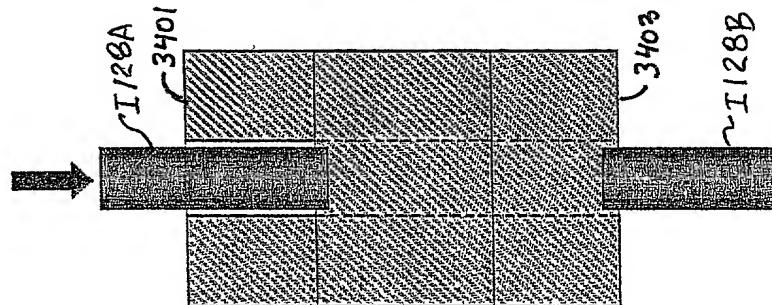


FIG. 133

Release and remove
 indenters

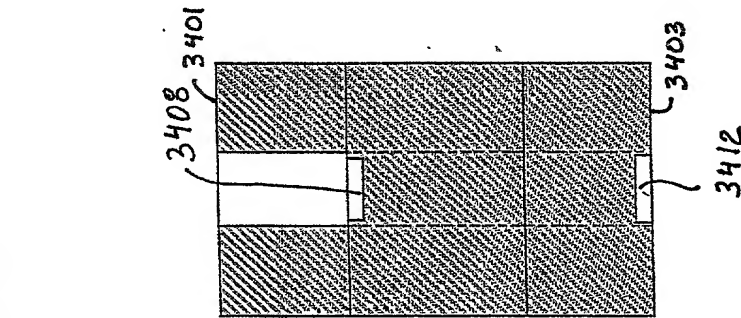


FIG. 134

Final machine
 hole

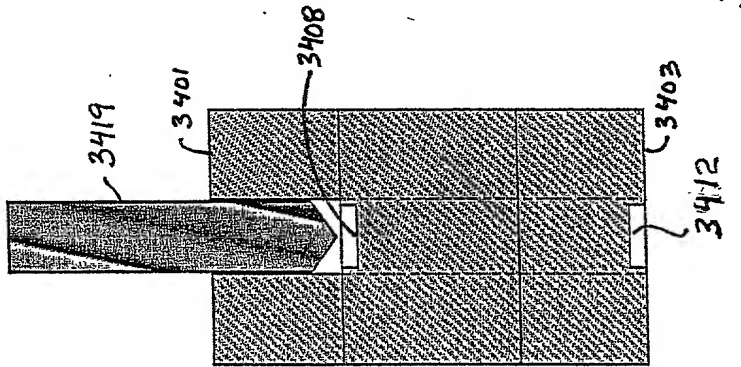
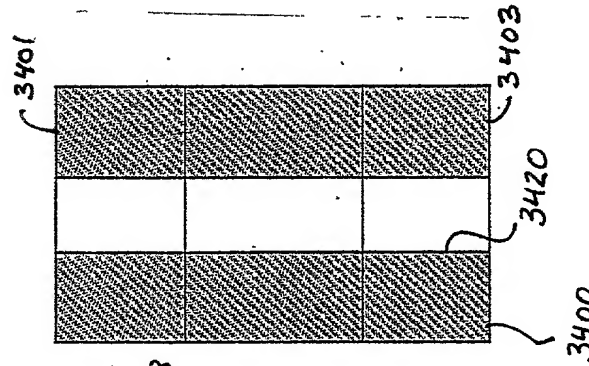


FIG. 135

Final configuration
 Note: hole may have
 countersink, counter-
 bore, step, or other
 feature.



44/50

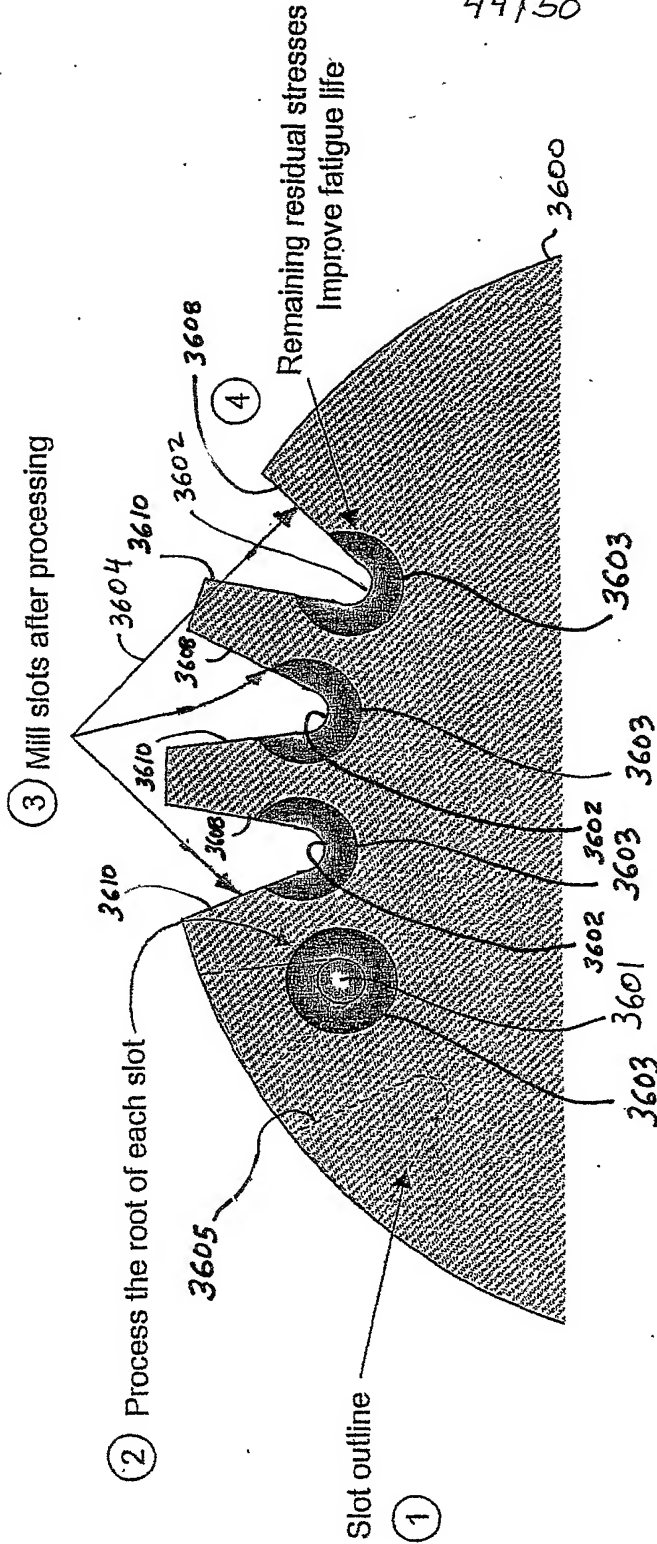


FIG. 136

Treatment of a slotted structure such as a gear or disk

2006T0-8049900T

200670" 8049900T

45/50

Docket No.: SI1-2627-U-C5 Sheet 45 of 50
Applicant: EASTERBROOK, Eric T.
Serial. No.: n/a Filing Date: 01/30/02
Title: METHOD AND APPARATUS FOR IMPROVING THE
FATIGUE LIFE OF COMPONENTS AND STRUCTURES
CALL: R. Reams Goodloe, Jr.
Phone: (253)859-9128/ Reg.#32,466/ Cust#20793

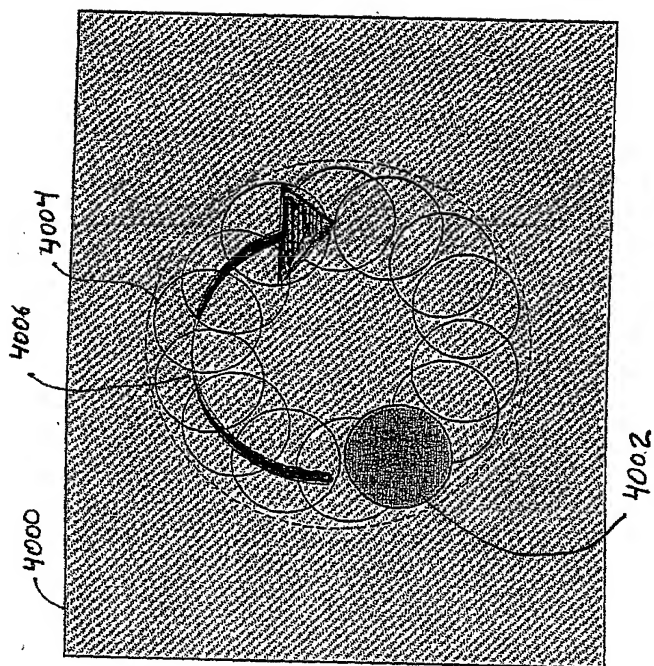


FIG. 137

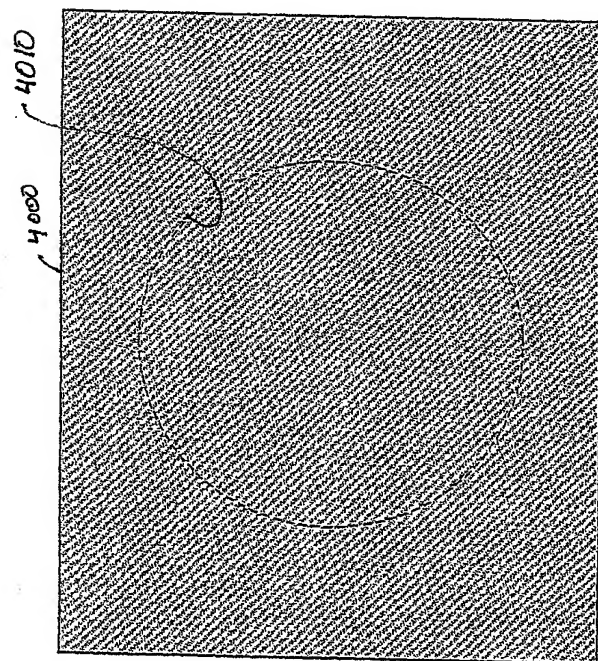


FIG. 138

Treatment of a
round aperture using an
overlapping pattern of
dimples around the perimeter

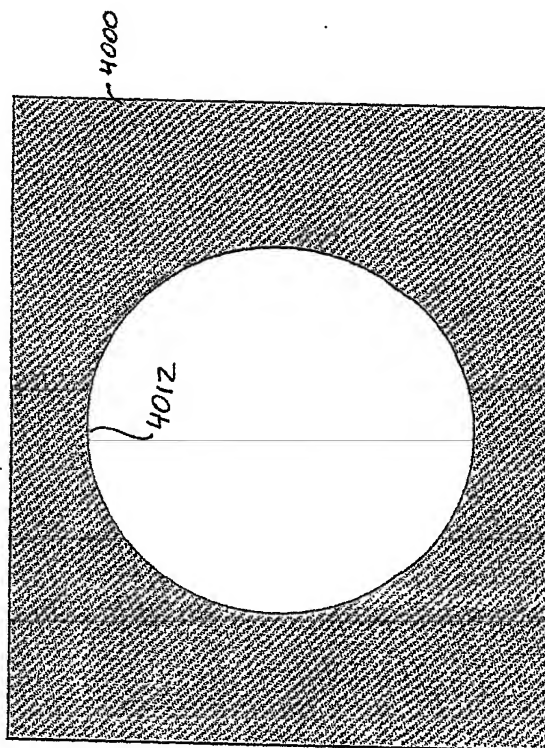


FIG. 139

46/50

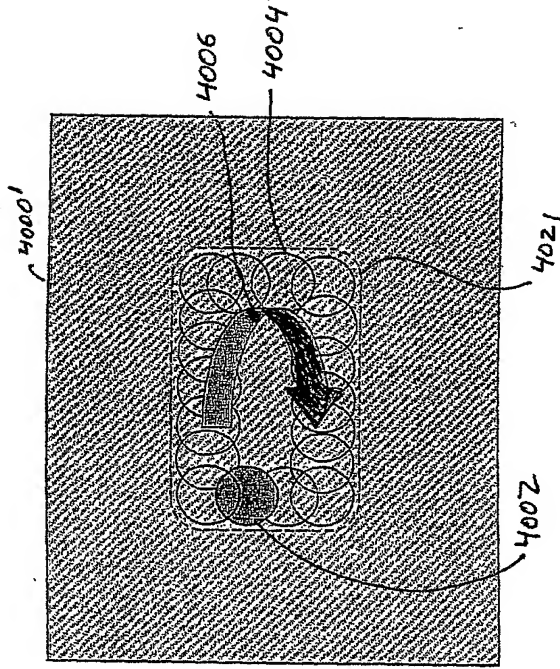


FIG. 141

Treatment of a
 non-circular aperture using
 an overlapping pattern of
 dimples around the perimeter

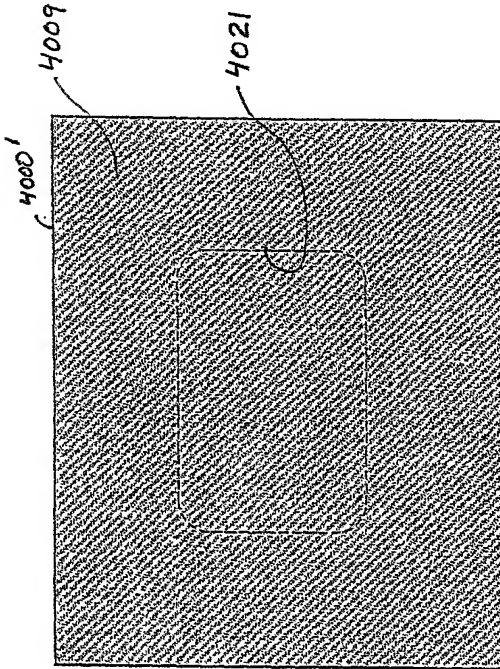


FIG. 140

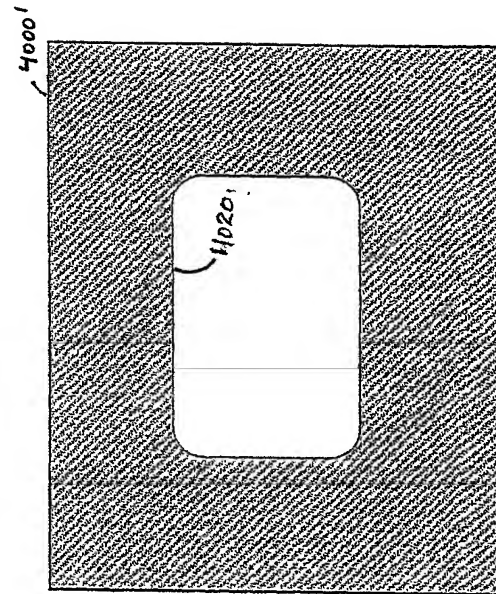
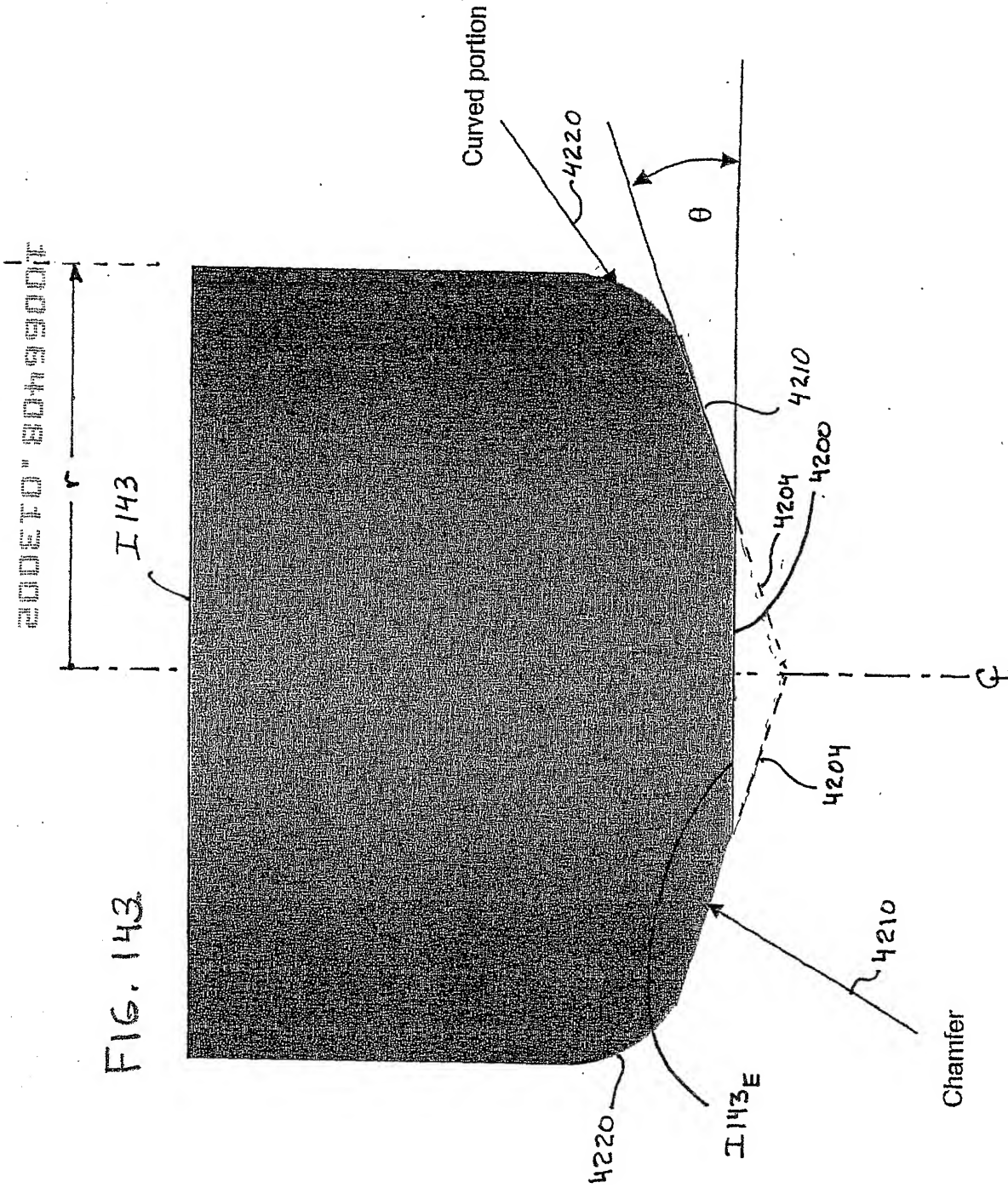


FIG. 142

2006 TO 80499007

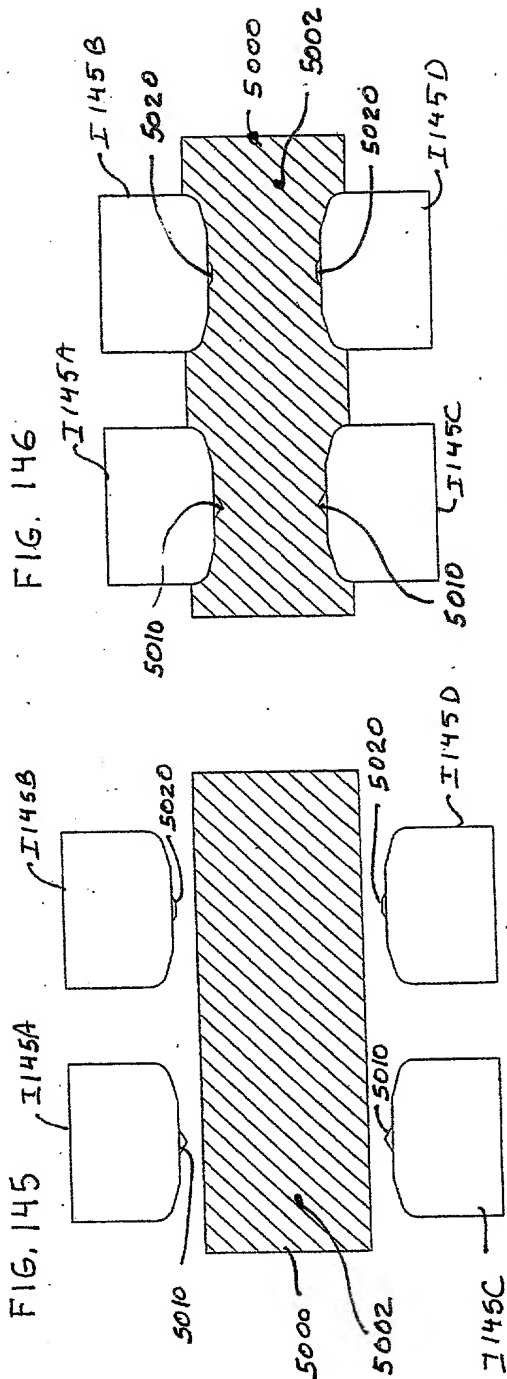
47/50



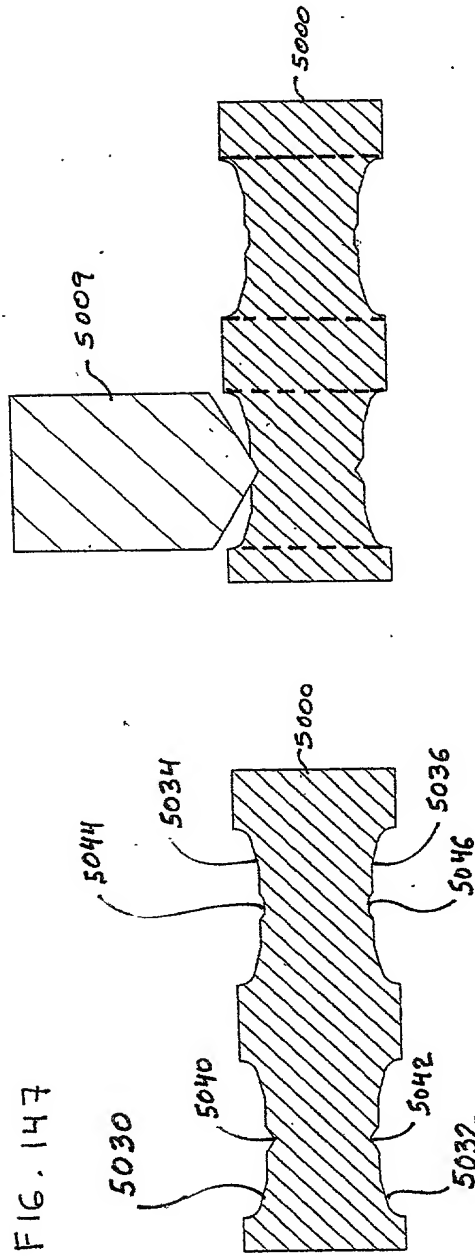
Indenter end shape using flat, chamfered and curved portions for approximating a uniform pressure profile



Indenter end shape for approximating a uniform pressure profile with drill center feature



Setup Step for Two Indenter End Styles
With Drill Aligning Feature, One Conical and the
Other a Truncated Cone



Actuation of Indenters Into Part

Cross Section of Dimples After
Treatment and Indenter Withdrawl

Drill Out Hole, Drill Centers on Dimple

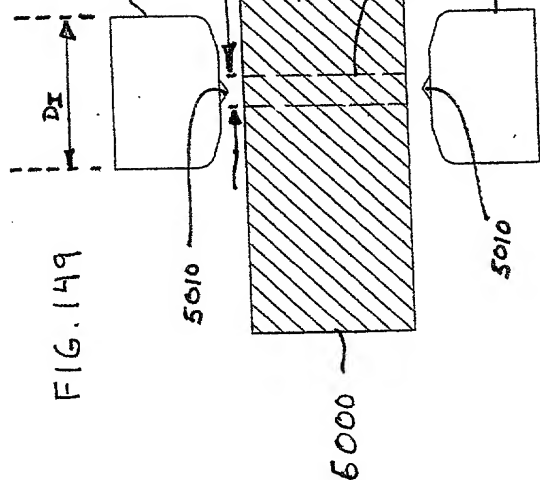


FIG. 149

Setup Step for Treating Part With Extra Thickness Using Indenters Much Larger Than the Final Hole Diameter

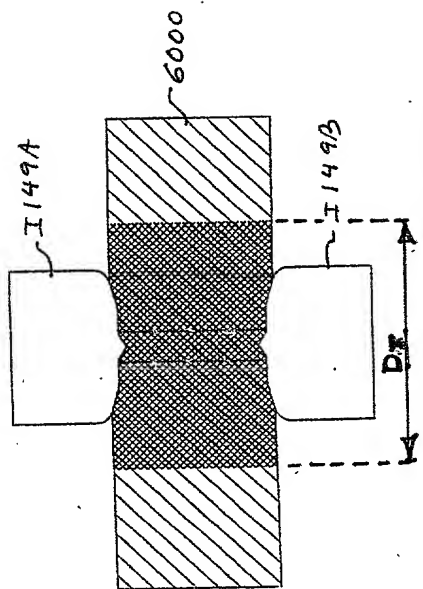


FIG. 150

Actuation of Indenters Into Part, Extent of Residual Stress Well Beyond the Future Wall of the Small Diameter Hole

FIG. 151

